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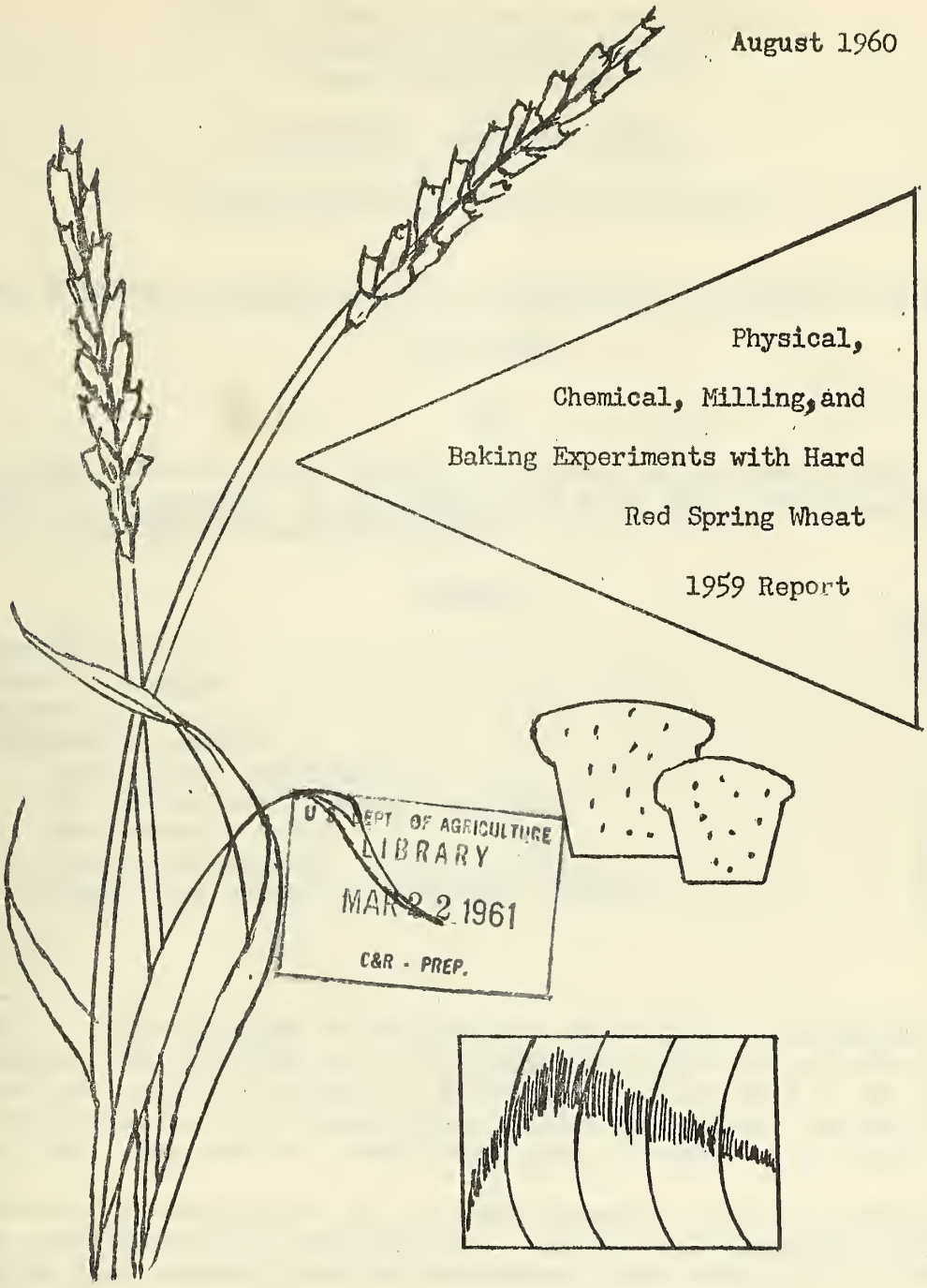
Physical, Chemical, Milling, and Baking Experiments with Hard Red Spring Wheat

1959 Report



United States Department of Agriculture
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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Crops Research Division
and
AGRICULTURAL MARKETING SERVICE

Preliminary report not for publication[1/]

PHYSICAL, CHEMICAL, MILLING, AND BAKING EXPERIMENTS WITH HARD RED SPRING WHEAT

1959 CROP[2/]

by

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1/ This is a progress report of cooperative investigations containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or any statements herein should not be made without prior written approval of the Crops Research Division, ARS, USDA, and the cooperating agency or agencies concerned.

2/ Cooperative investigations of the Crops Research Division, Agricultural Research Service, and the Grain Division, Agricultural Marketing Service. The samples were obtained from the cooperative experiments with the State Agricultural Experiment Stations in the spring wheat region.

Plant Industry Station
Beltsville, Maryland
CR-45-60

INTRODUCTION

Samples of the standard varieties and many of the new strains of hard red spring wheat grown in cooperative experiments in the spring wheat region of the United States 3/ are milled each year by the United States Department of Agriculture and the flours baked into bread to determine their quality characteristics.

The baking methods and techniques used on the 1959 crop were essentially the same as those used for the 1944 to 1958 crops, inclusive.

The purpose of this report is to make available to cooperators the quality data on standard varieties, new strains, and commercial hard red spring wheat from the 1959 crop.

SOURCE OF SAMPLES

Tests were made on composite and individual samples of the uniform varieties and many other varieties and strains grown in plot experiments at cooperating stations. These included samples grown at Madison, Wis.; Morris, Rosemount, Waseca, and Crookston, Minn.; Edgeley, Fargo, Williston, Langdon, Dickinson, and Minot, N. Dak.; and Brookings, S. Dak. Similar tests were made on Eastern and Western composites of the 27 strains of wheat grown in the uniform regional nurseries and on the wheats from the station nurseries in Montana.

There were also included 28 samples composited by grade from samples of carlot receipts of wheat accumulated during a 90-day period of the 1959 crop movement by the Minneapolis, Duluth, and Great Falls offices of the Grain Division. These samples represent country-run receipts of the class hard red spring wheat and included only those lots that were graded No. 5 or better under the Official Grain Standards of the United States. These hereafter are referred to as commercial samples. This is the twenty-first season that such samples have been collected and tested.

METHODS

For the benefit of the readers who are not familiar with the tests and terminology used in this report, the following terms are explained:

Test weight per bushel is the weight per Winchester bushel determined in the laboratory on dockage-free wheat.

3/ Ausemus, E. R. Results on spring wheat varieties grown in cooperative plot and nursery experiments in the spring wheat region in 1959. U. S. Department of Agriculture, Agricultural Research Service, Crops Research Division, CR-13-60, 79 pp., University Farm, St. Paul, Minn. (Processed). January 1960.

Flour yield is the percentage of flour derived from the wheat milled on a Buhler automatic laboratory mill. Ten percent of the low grade flour was discarded, leaving a 90-percent patent flour which was used for the chemical and bread-baking tests. However, the flour yield data in the tables are reported on the basis of a straight grade flour (100 percent) obtained from each sample. Yields are expressed on a moisture-free basis.

Pearling index is a measure of the hardness of the grain determined by pearling 20 grams of dockage-free whole wheat for 1 minute in a model No. 38 Strong-Scott pearler. The amount of material pearled off, expressed as a percentage of the wheat, is called the pearling index. This index has been found useful as a guide in tempering the samples for milling and as a measure of the hardness of the grain. A low index figure indicates hard grain and a high index figure indicates soft grain.

Protein content is nitrogen determined by the standard Kjeldahl procedure multiplied by the conversion factor 5.7. Values are reported on a 14.0 percent moisture basis.

Ash content is the residue after igniting a sample of flour. Low or high ash appears to be an inherent property of the wheat. Ash content is expressed on a 14.0 percent moisture basis.

Sedimentation value (wheat) is determined by the method described in Cereal Laboratory Methods, Sixth Edition (1957). It is a combined index of gluten content and gluten quality and a high value is, therefore, a rough measure of superior bread-baking strength. Sedimentation values are reported on a 14.0 percent moisture basis.

Mixing time is the optimum time necessary to obtain a dough of maximum consistency in the bread-making process.

Absorption is the optimum amount of water in percent required to bring the dough to the desired standard consistency.

The mixogram curve is a record of the torque produced on the lever system of a mixograph when dough is mixed. The results of these tests are reported in the tables under the headings of (1) development time and (2) mixing tolerance. The development time is the period required in minutes for a dough to reach the peak or maximum development, or the time needed to develop the dough properly for the best bread. A very rapid curve rise to the peak results in a short development time and a quick decrease in curve height following the peak indicates a lack of dough stability during mixing. Mixing tolerance is the time in minutes the dough maintains its resistance against mechanical action with little decline in the height of the curve. In general, a gradual curve rise with a slow decline (shown as mixing tolerance in the tables) after reaching the peak indicates a dough of good stability during mixing. Mixogram patterns have been studied, and their significance as relating to quality is discussed in the text. Mixing tolerance is a property of flour in great demand by commercial bakers.

The bread-baking tests were made by a formula using 100 grams of flour, 2.0 grams of compressed yeast, 2.0 grams of salt, 5.0 grams of sugar, 0.25 grams of malted wheat flour, 3.0 grams of shortening, 4.0 grams of nonfat-dry milk, and varying amounts (0 to 3 mg.) of potassium bromate. The doughs were fermented for 3 hours at 86° F. (30° C.), proofed for 55 minutes at 86° F. (30° C.), and then baked for 25 minutes at 440° F. Loaf-volume data are presented only for those loaves containing that amount of potassium bromate that produced maximum loaf volumes. In most instances the loaf having the greatest volume also had the best grain, texture, and crumb color.

Bread loaf volume must be adequate for the protein content of the flour if the variety is to be considered satisfactory. The loaf volumes are shown in the tables on an "as is" protein basis and, in addition, on an expected loaf volume basis. The expected loaf volume based on flour protein content is the loaf volume obtained from baking experiments in which the flour from 589 samples of 10 hard red spring wheat varieties was tested for the crop years 1944 to 1947. The higher "as is" loaf volumes generally are associated with superior bread-baking strength.

A check or standard flour (12.9 percent protein and 0.47 percent ash on a 14.0 percent moisture basis) was included in the baking trials with each day's test. The average volume of the loaves made with the standard flour was 814 cc. and the standard error was 23.5 cc. On this basis the least significant difference between 2 single bakes was 66 cc.

The quality properties of each variety with respect to crumb grain and color of the bread are shown numerically in the tables. The following scores may be used as an index for judging these 2 properties:

59 or below	Very poor or unsatisfactory
60 to 69	Poor or questionable
70 to 79	Fair
80 to 89	Good
90 to 99	Very good
100 and above	Excellent

Varieties or selections having loaf volumes approximately 125 cc. less than expected, as based on the flour protein content, are questionable; and those having loaf volumes less by approximately 200 cc. or more are unsatisfactory.

An unsatisfactory rating on one or more of the properties would indicate that the variety or strain is generally undesirable for hard wheat milling or bread-making purposes except that a questionable rating on one or more of the quality properties may be balanced by other outstanding properties. The milling properties are discussed in the text and should be considered along with the bread-baking properties.

EXPERIMENTAL RESULTS

Station Plot Experiments

The quality data for the uniform varieties and other wheats grown in plots are shown in table 1.

Wisconsin - Wheat samples were received only from Madison.

Nearly all of the wheats were damaged with the possible exceptions of Henry (C.I. 12265), H 305-2 and Henry[7] x P.I. 94587 (C.I. 13457). This factor no doubt influenced some of the quality characteristics, particularly in the way the wheats handled in the milling process and the ash content of the flour. All of the damaged wheats milled either fair or poor. However, the flour yields were relatively good in spite of the low test weights of the wheats. Most of the varieties and strains generally made satisfactory bread with some better than others. The loaf volumes for the most part, were slightly lower than expected considering the protein content of the flour.

There was little variation in water absorption among the samples. The range was from 62 to 70 percent, with Selkirk highest. Dough mixing times were similar for all the samples and about average for hard red spring wheats. The bread crumb grain scored good to very good for all the samples, but the crumb color scores were a little lower than desired for most of the loaves.

The approved and named hard red spring varieties Henry, Thatcher, Lee, Selkirk, and Conley made satisfactory bread. Conley and Thatcher were perhaps the strongest of these, making bread of good loaf volume and satisfactory internal characteristics. The mixogram patterns for both varieties were strong, showing relatively long development times and mixing tolerances. Henry was perhaps the weakest in quality of the named varieties. This was due, in part, to its lower protein content in comparison with the other comparably grown wheats. It was best, however, of the varieties in the yield of flour.

H 305-2 milled satisfactorily, producing a high yield of flour of relatively low ash content. The absorption in the bread-making process was high, and the dough handling properties elastic and pliable, but slightly sticky. The mixogram pattern for strain H 305-2 shows that it had a relatively long development time but a short mixing tolerance. The loaf volume of the bread was about that expected considering the flour protein content, and the grain of the bread was very good.

Tests of the recently named Canadian variety Canthatch (C.T. 233, C.I. 13345) show it to be similar to Thatcher in quality although the quality of dough was somewhat better according to the mixogram tests. It had the longest development time and mixing tolerance of the Madison samples. It made good bread and the grain was excellent.

Table 1.--Yield, milling, baking, and chemical results for hard red spring wheats grown in replicated plots in 1959.[1/]

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Madison, Wisconsin																	
Henry	12265	55.3	31	13.9	12.7	77.4	.57	62	2.25	49	2	790	70	85	840	3.00	1.25
Thatcher	10003	53.0	22	15.1	14.3	73.7	.65	67	2.50	62	2	855	75	95	920	3.75	3.00
Lee	12488	55.5	27	16.0	15.0	73.6	.69	67	2.75	58	2	835	80	85	955	3.25	1.75
Selkirk	13100	52.9	29	15.8	15.0	74.9	.62	70	2.25	65	2	895	80	95	955	3.00	2.00
Conley	13157	50.1	25	15.8	15.0	73.0	.64	68	2.75	73	2	905	80	100	955	3.75	3.00
H 305-2	--	57.6	28	13.9	13.0	77.1	.61	67	2.00	51	2	850	70	95	855	2.75	1.25
Canthatch (CT 233)	13345	54.3	24	15.2	14.1	73.9	.61	65	2.50	56	2	865	70	95	910	4.75	4.00
C.I. 12633 x Henry[2] (sel. 1-1)	--	56.7	31	15.0	14.0	76.1	.64	65	2.25	51	2	860	75	95	905	2.50	2.00
H 515b-7-2-12-5	--	55.0	30	15.1	14.0	73.5	.60	66	2.50	50	2	900	75	95	905	3.25	1.25
Henry[7] x P.I. 94587	13457	57.1	33	13.4	12.4	76.8	.58	62	2.00	48	2	778	70	85	825	3.00	1.25
Crookston, Minnesota																	
Thatcher	10003	56.0	29	13.9	13.5	76.2	.51	67	3.00	64	2	908	75	100	880	--	--
Lee	12488	58.4	36	15.5	15.0	77.1	.54	69	3.00	64	2	925	90	95	955	3.75	2.00
Selkirk	13100	56.4	37	15.2	14.8	78.2	.55	70	2.50	63	2	928	75	95	945	3.00	2.75
Conley	13157	56.3	34	15.3	14.5	77.5	.50	68	2.75	67	2	930	90	95	930	3.50	2.00
Canthatch (CT 233)	13345	57.3	30	13.7	13.6	76.3	.46	67	2.75	64	1	880	75	90	885	4.00	3.00
II-44-29 x Lee[3]	13415	59.0	36	15.4	14.5	77.2	.45	67	3.00	68	2	840	80	95	930	4.75	5.75
Pembina (CT 229)	13332	57.9	35	15.6	14.9	78.2	.48	67	3.25	74	2	910	65	100	950	5.50	5.50
ND 81 x Lee	13349	59.9	35	16.1	15.2	73.9	.50	69	2.75	63	1	900	75	95	965	3.50	2.00

Table 1.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Morris, Minnesota																	
Thatcher	10003	59.1	29	16.4	14.9	74.6	.56	70	2.50	67	2	968	60	85	950	--	--
Lee	12488	60.6	32	16.0	15.5	74.7	.63	70	3.25	72	1	870	90	90	980	3.50	3.50
Selkirk	13100	56.7	32	16.1	15.6	74.1	.56	70	2.75	70	2	905	75	95	985	2.50	2.75
Conley	13157	59.7	30	15.3	14.6	75.2	.55	70	2.75	70	2	880	80	95	935	3.50	2.50
Canthatch (CT 233)	13345	59.7	30	16.7	16.0	74.2	.53	67	2.50	70	2	925	75	85	1005	3.25	3.25
II-44-29 x Lee[3]	13415	60.8	34	15.6	14.7	76.5	.52	68	3.50	70	2	825	75	90	940	4.25	5.25
Pembina(CT 229)	13332	57.7	31	16.3	15.7	74.2	.54	66	3.00	71	2	845	75	95	990	5.00	4.25
ND 81 x Lee	13349	60.1	34	16.4	15.9	74.8	.63	69	3.25	69	2	903	80	95	1000	3.75	3.75
Rosemount, Minnesota																	
Thatcher	10003	59.7	24	13.8	13.1	75.6	.52	66	3.00	53	2	843	65	95	860	--	--
Lee	12488	61.2	30	15.4	14.8	76.4	.51	69	3.50	63	2	865	90	95	945	4.00	3.50
Selkirk	13100	57.6	31	15.3	14.3	75.3	.53	71	2.50	66	2	885	75	95	920	3.00	2.75
Conley	13157	57.3	27	15.1	14.5	76.5	.50	68	3.00	65	2	910	80	100	930	3.50	3.00
Canthatch (CT 233)	13345	58.4	24	13.9	13.3	74.7	.47	67	3.00	62	1	850	65	90	870	4.00	4.00
II-44-29 x Lee[3]	13415	60.7	31	15.5	14.6	77.3	.48	68	3.50	68	2	883	75	90	935	5.25	5.00
Pembina (CT 229)	13332	59.1	28	15.3	14.8	76.0	.51	68	4.00	71	1	893	75	95	945	5.50	5.75
ND 81 x Lee	13349	60.5	33	15.8	15.2	74.8	.54	69	3.00	65	1	885	85	95	965	3.50	2.25

Table 1.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Waseca, Minnesota																	
Thatcher	10003	60.2	24	12.4	11.5	76.8	.54	69	3.00	54	2	763	70	85	780	--	--
Lee	12488	61.2	30	13.3	12.7	76.5	.54	68	2.50	64	2	805	85	90	840	3.50	2.50
Selkirk	13100	58.1	28	12.9	12.6	75.2	.50	68	2.75	66	2	785	80	100	835	4.00	4.25
Conley	13157	59.6	26	12.4	11.8	78.0	.51	68	2.75	66	2	750	80	85	795	3.75	4.25
Canthatch (CT 233)	13345	60.2	24	12.5	11.6	75.5	.51	68	3.00	64	1	773	70	90	785	3.75	5.00
Average data for eight varieties and strains from three Minnesota stations[2/]																	
Thatcher	10003	58.3	27	14.7	13.8	75.5	.53	68	2.83	61	2	903	67	93	895	--	--
Lee	12488	60.1	33	15.6	15.1	76.1	.56	69	3.25	66	2	887	90	93	960	3.75	3.00
Selkirk	13100	56.9	33	15.5	14.9	75.9	.55	70	2.58	66	2	906	75	95	950	2.83	2.75
Conley	13157	57.8	30	15.2	14.5	76.4	.52	69	2.83	67	2	907	83	97	930	3.50	2.50
Canthatch (CT 233)	13345	58.5	28	14.8	14.3	75.1	.49	67	2.75	65	1	885	72	88	920	3.75	3.42
II-44-29 x Lee[3]	13415	60.2	34	15.5	14.6	77.0	.48	68	3.33	69	2	849	77	92	935	4.75	5.33
Pembina (CT 229)	13332	58.2	31	15.7	15.1	76.1	.51	67	3.08	72	2	883	72	97	965	5.33	5.17
ND 81 x Lee	13349	60.2	34	16.1	15.4	74.5	.56	69	3.00	66	1	896	80	95	945	3.58	2.67

Table 1.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb			Development time	Mixing tolerance
													Color	Grain			
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Brookings, South Dakota																	
Marquis	3641	58.4	31	15.9	15.2	75.3	.59	65	2.25	70	2	898	80	85	965	2.50	1.75
Ceres	6900	58.4	29	16.5	15.7	75.1	.58	66	2.50	71	1	893	90	90	990	3.00	2.50
Thatcher	10003	57.6	32	17.0	16.4	75.6	.59	66	2.25	70	1	940	80	95	1025	3.00	2.50
Mida	12008	60.6	37	16.3	15.4	77.1	.58	68	2.25	64	2	843	90	90	975	2.25	1.50
Rushmore	12273	58.3	36	16.0	15.3	78.1	.66	67	2.50	68	2	880	75	90	970	3.50	2.50
Lee	12488	57.5	35	17.0	16.6	75.9	.61	67	2.50	66	2	885	85	95	1035	3.00	2.25
Willet	13099	56.0	43	17.6	16.9	73.7	.53	66	1.50	46	2	908	80	95	1050	1.75	1.00
Selkirk	13100	53.8	32	16.4	16.1	75.0	.58	66	2.00	69	2	935	80	90	1010	3.50	2.25
Conley	13157	57.1	35	15.7	15.0	76.1	.58	67	2.50	71	2	863	75	95	955	3.25	1.75
Rush. x Haynes Blue.	13162	58.9	35	16.8	16.4	76.7	.57	67	1.50	70	2	915	70	90	1025	1.75	1.75
Lee[2] x Ken. Farmer	13221	57.2	35	17.4	16.7	73.9	.60	67	2.25	64	2	875	90	100	1040	3.50	2.50
Thatcher x Ken. Farmer	13211	58.0	32	17.0	16.4	76.4	.60	66	2.50	71	1	953	75	95	1025	3.25	2.25
Spinkcota	12375	60.6	44	17.2	16.6	73.4	.55	63	2.00	53	2	893	80	90	1035	3.25	1.75
Etta	13346	60.8	41	17.3	16.9	76.7	.54	64	2.00	71	2	955	75	95	1050	2.75	1.50
Dickinson, North Dakota																	
Thatcher	10003	58.1	30	16.1	15.3	73.8	.58	60	2.00	66	2	928	85	95	970	--	--
Conley	13157	57.3	30	16.4	14.5	73.0	.56	62	2.25	68	2	948	95	95	930	--	--
Selkirk	13100	56.4	32	14.9	14.3	76.0	.56	62	2.50	68	1	865	80	95	920	--	--
Lee	12488	58.0	31	16.5	15.5	67.6	.54	62	2.25	62	2	925	85	95	980	--	--
Mida	12008	58.7	29	15.8	14.9	71.4	.50	62	2.25	63	1	910	90	95	950	--	--
II-44-29 x Lee[3]	13415	58.7	32	16.3	15.3	73.7	.52	62	2.25	67	2	975	90	95	970	--	--

Table 1.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb			Development time	Mixing tolerance
													Color	Grain			
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Edgeley, North Dakota																	
Thatcher	10003	55.9	29	14.6	14.1	73.3	.51	62	2.00	64	2	903	80	100	910	--	--
Selkirk	13100	54.8	34	15.2	14.9	74.2	.53	64	2.00	67	2	938	85	100	950	2.75	1.75
Lee	12488	57.0	39	16.4	15.8	72.8	.54	65	2.00	57	2	935	95	100	995	2.25	1.25
Mida	12008	59.0	34	14.1	13.1	73.1	.47	62	2.00	59	2	865	100	100	860	—	--
Conley	13157	55.9	33	14.6	14.3	73.2	.48	62	2.25	63	2	878	100	100	920	3.25	2.75
ND 81 x Lee (ND 137-2)		57.1	38	17.2	16.7	73.5	.56	65	2.00	67	2	933	80	100	1040	2.50	1.25
ND 81 x Conley	13452	56.4	32	14.7	14.4	73.0	.54	62	2.00	62	2	863	95	100	925	3.75	2.75
Lee x ND 34	13461	58.4	35	16.9	15.5	71.2	.51	60	2.25	69	2	945	95	100	980	2.50	1.50
Pembina (CT 229)	13332	56.7	33	16.1	16.0	73.2	.53	62	3.00	72	2	945	85	100	1005	4.00	4.00
Canthatch (CT 233)	13345	57.4	30	15.2	14.5	72.9	.51	60	2.50	68	2	905	75	90	930	3.00	2.00
II-44-29 x Lee[3]	13415	57.4	36	15.4	14.9	74.8	.51	64	3.25	70	2	898	75	100	950	3.75	3.75
Fargo, North Dakota																	
Thatcher	10003	59.4	22	12.1	11.7	72.1	.58	62	3.50	45	1	758	75	95	790	—	—
Selkirk	13100	58.9	28	12.5	11.8	73.7	.57	61	2.75	44	1	793	85	95	795	3.50	3.00
Lee	12488	60.4	29	13.0	12.2	73.3	.54	64	3.00	47	1	773	90	95	815	4.00	5.00
Conley	13157	58.9	26	12.1	11.6	71.4	.56	64	3.50	48	1	760	85	90	785	3.75	6.00
ND 81 x Lee (ND 137-2)		60.6	28	12.8	12.1	71.8	.59	63	2.50	52	2	690	75	75	810	4.75	6.75
ND 81 x Conley	13452	60.3	27	12.7	11.4	73.2	.52	65	3.00	41	2	715	75	90	775	4.75	6.25
Lee x ND 34	13461	60.7	28	12.8	12.0	73.7	.55	64	2.50	44	2	755	75	75	805	3.75	3.75
Pembina (CT 229)	13332	58.8	25	13.7	12.9	72.5	.57	62	3.75	66	2	745	75	85	850	5.75	6.75
Canthatch (CT 233)	13345	59.7	23	12.4	11.9	74.4	.56	62	3.25	49	2	725	75	80	800	4.25	5.75
II-44-29 x Lee[3]	13415	60.5	28	11.9	11.0	75.4	.51	64	3.50	48	2	723	70	80	755	4.75	6.00
ND 81 x Lee	13349	60.5	29	12.8	11.1	73.4	.53	63	2.50	53	1	718	75	70	760	3.50	5.75

Table 1.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Langdon, North Dakota																	
Thatcher	10003	56.0	24	14.2	13.1	72.1	.51	62	2.75	53	2	855	70	80	860	--	--
Selkirk	13100	56.4	28	14.3	13.8	73.4	.53	64	2.75	67	1	845	85	95	895	3.00	3.00
Lee	12488	58.5	28	15.0	14.3	73.3	.54	65	3.00	67	2	855	75	95	920	3.00	2.00
Mida	12008	58.9	26	14.2	13.4	75.4	.52	64	2.25	67	2	848	70	90	875	--	--
Conley	13157	56.7	26	14.0	13.2	74.1	.57	64	3.00	67	2	850	75	90	865	3.25	1.75
ND 81 x Lee (ND 137-2)		59.3	28	15.3	14.8	74.6	.61	66	3.00	61	2	970	80	95	945	3.00	2.25
ND 81 x Conley	13452	58.0	26	14.2	13.5	72.9	.55	65	2.75	53	2	903	75	100	880	3.75	2.50
Lee x ND 34	13461	60.5	29	14.6	13.8	75.9	.54	67	2.50	58	2	875	85	95	895	2.50	1.75
Pembina (CT 229)	13332	58.1	27	14.8	13.9	73.1	.53	65	3.00	66	1	885	70	95	900	3.50	4.75
Canthatch (CT 233)	13345	57.7	24	14.1	12.9	73.4	.53	63	2.75	48	2	863	75	95	850	3.50	3.00
II-44-29 x Lee[3]	13415	58.7	30	15.0	14.0	74.2	.53	65	3.00	55	2	858	85	100	905	3.25	3.50
Minot, North Dakota																	
Thatcher	10003	56.5	28	16.2	15.6	73.5	.53	63	2.50	47	1	935	75	100	985	--	--
Selkirk	13100	55.4	31	15.3	14.7	76.7	.51	64	2.50	54	2	910	80	100	940	2.75	2.25
Lee	12488	57.8	31	16.2	15.6	73.1	.54	64	2.50	42	2	898	75	95	985	2.25	1.50
Mida	12008	58.6	29	15.7	14.8	78.9	.50	62	2.75	61	1	875	85	95	945	--	--
Conley	13157	54.7	31	16.2	15.4	74.6	.46	61	2.75	70	2	995	75	90	975	2.75	2.00
ND 81 x Lee (ND 137-2)		56.9	32	16.8	15.9	72.8	.52	62	3.25	68	1	935	75	95	1000	3.00	2.50
ND 81 x Conley	13452	56.0	31	15.9	15.0	73.7	.50	62	2.75	65	2	893	75	95	955	3.25	2.00
Lee x ND 34	13461	60.0	32	16.5	15.3	72.6	.53	63	1.75	66	2	920	90	95	970	2.00	1.00
Canthatch (CT 233)	13345	56.8	29	16.2	15.2	72.4	.48	61	2.75	72	2	925	80	100	965	3.25	4.75
Pembina (CT 229)	13332	57.5	27	16.4	15.7	74.3	.47	62	3.50	71	2	925	65	90	990	2.75	3.00
II-44-29 x Lee[3]	13415	56.3	32	16.0	15.3	74.3	.50	62	3.00	69	3	913	80	95	970	4.00	3.25

Table 1.—(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Williston, North Dakota																	
Thatcher	10003	52.7	30	18.2	17.0	71.8	.54	61	1.75	69	2	923	70	90	1055	--	--
Lee	12488	50.5	34	19.5	18.6	71.8	.57	62	2.50	63	3	950	90	90	1135	--	--
Selkirk	13100	48.5	31	16.8	16.3	72.8	.57	63	2.50	60	2	920	80	95	1020	--	--
Conley	13157	49.2	34	19.5	18.2	71.0	.52	64	2.75	70	2	1030	75	80	1115	--	--
Mida	12008	53.8	32	18.6	17.4	73.5	.48	64	2.00	69	2	900	80	90	1075	--	--
Lee x ND 34	13461	54.6	35	18.6	17.7	71.5	.60	61	2.25	66	2	900	85	90	1090	--	--
II-44-29 x Lee [3]	13415	48.2	33	19.6	18.5	69.9	.58	63	2.25	71	3	985	85	95	1130	--	--
Canthatch (CT 233)	13345	50.7	30	19.8	18.8	69.0	.55	61	2.25	68	2	965	75	85	1145	--	--
Average data for eleven varieties and strains from four North Dakota Stations 3/																	
Thatcher	10003	57.0	26	14.3	13.6	72.8	.53	62	2.69	52	2	863	75	94	885	--	--
Selkirk	13100	56.4	30	14.3	13.8	74.5	.54	63	2.50	58	2	872	84	98	895	3.00	2.50
Lee	12488	58.3	32	15.2	14.5	73.1	.54	64	2.63	53	2	865	84	96	930	2.88	2.44
Mida	12008	58.8	30	14.7	13.8	75.8	.50	63	2.33	62	2	863	85	95	895	--	--
Conley	13157	56.6	29	14.2	13.6	73.3	.52	64	2.89	62	2	871	84	88	885	3.25	3.13
ND 81 x Lee (ND 137-2)		58.5	32	15.5	14.9	73.2	.57	64	2.69	62	2	882	78	91	950	3.31	3.19
ND 81 x Conley	13452	57.7	29	14.4	13.6	73.2	.53	64	2.63	55	2	844	80	96	885	3.88	3.38
Lee x ND 34	13461	59.8	31	15.2	14.2	73.3	.53	64	2.25	59	2	874	86	91	915	2.69	2.00
Pembina	13332	57.8	28	15.3	14.6	73.3	.53	63	3.31	69	2	875	74	88	935	4.00	4.63
Canthatch	13345	57.9	26	14.5	13.6	73.3	.52	62	2.81	57	2	855	76	91	885	3.50	3.88
II-44-29 x Lee [3]	13415	58.2	32	14.6	13.8	74.7	.51	64	3.19	60	2	848	78	94	895	3.94	4.13

1/ See text for methods and moisture basis for various quality determinations.
2/ Rosemount, Morris, and Crookston stations.
3/ Langdon, Minot, Fargo, and Edgeley stations.

C.I. 12633 x Henry[2] (sel. 1-1) appears to be similar to Henry for most of the quality characteristics for which comparisons have been made. The only exceptions to this were its higher protein content (1.1 percent in the wheat) and its 0.07 percent higher ash content in the flour. The loaf volume of the bread was about that expected and the grain of the bread was excellent. The dough properties of sel. 1-1 according to the mixogram tests were moderately strong. The doughs at the time of panning were pliable, elastic, and slightly sticky.

Comparable quality tests of H 515 b-7-2-12-5 show that it was generally similar to Selkirk for many of the properties compared. Three exceptions to this should be pointed out. It was 0.7 percent lower in wheat protein content, was 4 percent lower in absorption, and had a shorter mixing tolerance time according to the mixogram tests than Selkirk. H 515 b-7-2-12-5 produced about the same loaf volume as Selkirk although it was lowest of the two (by 1 percent) in flour protein. The doughs were pliable but slightly sticky at the time of panning.

Henry[7] x P.I. 94587 (C.I. 13457) was very similar to Henry except possibly for a few quality characteristics. It had a higher test weight per bushel (1.8 lbs.) and a lower wheat protein content (0.5 percent) than the comparably grown sample of Henry. It produced a lower yield of flour (0.6 percent) although it was highest of the two in test weight. This suggests that the cross may produce less flour than comparably grown samples of Henry of the same or similar test weight. The milling properties of C.I. 13457 were satisfactory according to the single sample tested. The pearling index indicates that this selection is a medium soft wheat and not so hard in texture as most of the approved hard red spring wheats. It is similar to Henry in this respect. The dough-handling properties are not quite so satisfactory as those of Henry. They were judged as mellow, pliable, and slightly sticky. C.I. 13457 had a reasonably long dough development time but a short mixing tolerance time. Short mixing tolerance time is an undesirable property of this strain. Henry[7] x P.I. 94587 has made a loaf of bread very similar in quality to that made from Henry. The absorption was medium high and loaf volume about that expected for the protein content of the flour. The grain of the bread was satisfactory, but the color of the crumb was about the minimum for bread made from the approved hard red spring wheats.

Henry[7] x P.I. 94587 is not so strong quality-wise as Thatcher or Lee, included in this test as standards of comparison. It appears from this single test of C.I. 13457, considering the data as a whole, that this wheat is not quite so satisfactory in quality as Henry. Another year's test should be made.

Minnesota - Samples were received from 4 Minnesota stations, Crookston, Morris, Rosemount, and Waseca. The quality results for the samples from the 4 stations and the average data for the same 8 varieties and strains grown comparably at 3 of the stations--Morris, Crookston, and Rosemount, Minnesota, are shown in table 1. Only 5 of the 8 wheats were grown at Waseca.

Some general conclusions should be noted concerning the overall characteristics of this year's samples before starting the discussion of the varieties and strains. Most of the samples made reasonably good bread with little differences in quality between some varieties and strains. The protein content was generally highest for the Morris, Minnesota, samples followed by the Crookston and Rosemount samples, which were very similar, with the Waseca wheats lowest of the 4 stations. The ash contents of the flours for this year's Minnesota samples were somewhat higher than those tested last year. The flour yields were highest for the Crookston samples. Seven of the 8 wheats at this station produced exceptionally high flour yields ranging from 76.2 to 78.2 percent. It is of interest that the ash contents of the flours were also relatively low for a number of these samples.

The loaf volumes were highest (by a relatively narrow margin) for the Morris and Crookston samples, followed by the Rosemount samples, with the Waseca wheats lowest of the 4 stations.

The Minnesota varieties, as a group, produced bread that was exceptionally satisfactory in grain with some better than others. It is of interest that of the 29 wheats 18 of them made bread scoring 95 or better in crumb grain. Only 4 of the wheats produced bread scoring 85 in crumb grain, which is considered satisfactory according to our scoring system. Seventeen of the samples made bread scoring 75 or lower in crumb grain. The crumb of these was yellow and not so white as those scoring higher in color.

Two of the most promising characteristics of a number of strains were their strong dough development times and mixing tolerances according to the mixogram tests. A number of the strains were better than the approved and named hard red spring varieties in this respect. Many also had strong dough characteristics at the time of panning, indicating a satisfactory quality property in a bread flour. In general, the flour from this year's Minnesota wheats appeared to be stronger (tougher) in gluten properties than last year's samples. This would account for the somewhat longer mixing times required for proper development in comparison with previous years' samples. The oxidation requirements of the flours for best bread appear to be a little higher than last year except for 2 of the strains. The oxidation requirements for the latter were lower than those of the comparably grown approved hard red spring varieties tested this season.

The hard red spring varieties, Thatcher, Lee, Selkirk, and Conley made satisfactory bread. Conley was perhaps the strongest of these with Lee, Thatcher, and Selkirk next best in quality. The crumb color of the bread from Thatcher was poor, whereas the crumb color of Lee bread was very good and better than that of the other approved hard red spring wheats from the Minnesota stations. The bread grain was very good in the loaves from Conley and Selkirk. The mixogram patterns for the 3 varieties tested were strong, with Conley and Lee perhaps slightly superior to Selkirk in this respect. The dough-handling properties of the 4 varieties at the time of panning were good, being strong, elastic, and pliable.

Tests of the recently named Canadian variety Canthatch (C.I. 13345, C.T. 233) show that it was similar to Thatcher in a number of characteristics. It was much like Thatcher in test weight, pearling index, protein content of wheat, flour yield, water absorption, dough mixing time, and loaf volume. The loaf volume was about that expected for the protein content of the flour. Canthatch milled satisfactorily. It was slightly higher than Thatcher in flour protein content and crumb color of bread, and slightly lower in ash content of the flour and grain of the bread. The oxidation requirements of C.I. 13345 were only half that of Thatcher, a favorable property of the strain. The dough properties (development time and mixing tolerance) were strong and equal to, if not slightly better than, those of Conley, according to mixogram tests. The doughs of Canthatch at the time of panning were elastic and pliable, favorable properties of the strain.

Comparable chemical, milling, and baking tests of II-44-29 x Lee^{3} (sel. II-53-541) show that with the exception of a few properties, it was very similar to Lee in quality. Selection II-53-541 milled satisfactorily, producing a high yield of flour of lower ash content than Lee, a favorable characteristic. The oxidation requirements were high and the crumb grain of the bread very good and similar to Lee in this respect. The bread crumb color was only fair and not nearly so white as that in the loaves of the comparably grown samples of Lee. The loaf volume of the bread was about 10 percent lower than expected for the protein content of the flour. Average figures from the mixogram tests show that this strain has a long development time and mixing tolerance. This was one of the stronger wheats in dough-mixing properties of the comparably tested samples from the Minnesota stations. It was better in this respect than Selkirk, Conley, or Lee.

The Canadian variety Pembina, (C.T. 229), recently named, appears to be similar to Thatcher in quality. It milled satisfactorily, producing a good yield of flour of medium ash content, and was like Thatcher in these respects. It was materially higher (1.0 percent in the wheat) in protein content than Thatcher. The quality of the gluten in C.T. 229 appears to be somewhat poorer than expected, according to the flour protein as indicated by the loaf volume of the bread. The loaf volume of the bread for C.T. 229 was 883 cc. for 15.1 percent flour protein as compared with Thatcher with a loaf volume of 903 cc. having a protein content in the flour averaging 13.8 percent, or 1.3 percent lower. The internal bread characteristics, crumb color, and grain were slightly better than those of Thatcher. The dough properties (development time and mixing tolerance) were strong. This sample was one of the better strains in this respect of the wheats tested from Minnesota. It was similar to strain II-44-29 x Lee^{3} and better than Conley, Lee, or Selkirk in this respect.

Comparable tests of ND 81 x Lee (ND 137) show that it was very similar to Lee in quality. ND 137 milled satisfactorily but produced slightly less (1.5 percent) flour than Lee. Both were nearly the same in test weight. The loaf volume of the bread was satisfactory and about that expected for the flour protein content. The grain of the bread was very good but the crumb color was 10 points poorer than that of the bread made from Lee. The oxidation requirements of strain ND 81 x Lee were about 50 percent less (a favorable property) for optimum bread than most of the wheats from the plot trials. The quality of the doughs, according to the mixogram tests, indicated strong properties that were very similar to those of the comparably grown samples of Conley and Lee and better than those of Selkirk. The dough-handling properties of ND 137 at the time of panning were good, being elastic and pliable.

South Dakota - Samples were received only from Brookings.

All the samples made satisfactory bread with good loaf volumes and crumb grain. Some were better than others in crumb color. Small differences in many of the quality factors made it possible to consider the data as a whole for the purpose of discussion. A few exceptions will be pointed out.

Test weights and flour yields were good with only one or two exceptions. Selkirk had the lowest test weight of 53.8 pounds, slightly below that expected for approved hard red spring wheat. Flour yields for Willet, Lee^{6} x Kenya Farmer (C.I. 13221), and Spinkcota were down somewhat considering the test weights of the wheats. Milling characteristics were good for all but two of the wheats tested. Lee^{6} x Kenya Farmer and Spinkcota milled only fair. It is of interest that Etta handled very good during the milling process. Wheat protein ranged from 15.7 percent for Conley to a high of 17.6 percent for Willet.

Pearling index values showed Ceres with a value of 29, and Marquis with 31 were hardest in texture; the other varieties were slightly softer than normal. Undesirable softness was shown by Willet, Spinkcota, and Etta with values of 43, 44, and 41 percent, respectively. Ash contents were also quite high especially for Rushmore (.66), Lee (.61), Lee^{6} x Kenya Farmer (.60), and Thatcher x Kenya Farmer (.60). Willet, Spinkcota, and Etta were lowest in flour ash content among Brookings samples. Water absorptions were good with only a 5 percent range from the lowest (63 percent for Spinkcota) to the highest (68 percent for Mida).

Dough-mixing times in the bread-making process varied somewhat. Willet and Rushmore x Haynes Bluestem showed poor stability with short mixing times of 1.50 minutes each while somewhat stronger flours were evidenced by mixing times of 2.50 minutes for Ceres, Rushmore, Lee, Conley, and Thatcher x Kenya Farmer. Intermediate mixing times of 2.00 or 2.25 minutes were obtained for the other 7 samples tested. Optimum bromate requirements (2 mgs.) were the same for most of the flours. The exceptions were Ceres, Thatcher, and Thatcher x Kenya Farmer which produced optimum loaf volumes with only 1 mg. of potassium bromate, a desirable characteristic.

Although the loaf volumes for the most part were good, they were somewhat lower than expected in view of the protein contents of the flours. The greatest differences between the actual and the expected loaf volumes were for the samples Lee, Willet, Lee^{6} x Kenya Farmer, and Spinkcota.

Mixogram curves were obtained for most of the samples. A few of the older varieties were omitted because their behaviors in the dough-making process are rather well established. However, some of the approved varieties were included for purposes of comparison. The short development time (1.75 minutes) for Rushmore x Haynes Bluestem is a desirable factor but the short mixing tolerance is undesirable and shows poor stability to mixing. Lack of stability as indicated by short mixing tolerances was obtained for Mida, Spinkcota, and Etta.

This poor stability, coupled with mellow, short, slightly sticky or weak dough handling characteristics of some of the samples, as well as somewhat lower loaf volumes than expected, may indicate to the wheat damage to the wheat caused by climatic conditions. However, mellowness or weakness in the dough-making process is perhaps an inherent varietal characteristic of some varieties. Considering the quality data as a whole Lee^{6} x Kenya Farmer and Thatcher x Kenya Farmer appear to be strong bread wheats and similar to the better and approved commercial varieties.

North Dakota - Wheat samples were received from Langdon, Minot, Fargo, Edgeley, Williston, and Dickinson, North Dakota. The average data obtained on the samples from only the first 4 stations will be the basis for discussing the quality of the entries. The results for the Williston wheats were not included in the averages principally because of low test weights of these samples. The samples from Dickinson included only 6 of the 11 varieties and strains grown at the other stations and were also, therefore, not added to the 4-station averages. Some reference, for the purpose of comparison, will be made to the Williston and Dickinson samples at the end of the following discussion of the 4-station averages.

Most samples made reasonably good bread. The protein content was generally highest for the Minot and Edgeley, North Dakota, samples, followed by the Langdon samples, with Fargo wheats lowest of the 4 stations. The higher protein content accounts, in part, for the generally better loaf volumes obtained from the Minot and Edgeley samples. The Edgeley samples made bread that was particularly good in grain, and, with the exception of 4 wheats, all scored high in crumb color. The older approved and named varieties Thatcher, Selkirk, Lee, Mida, and Conley generally made satisfactory bread, with some better than others. The crumb color of the bread for Thatcher and the grain of the bread for Conley was lower than that of the other 4 varieties. Conley had the strongest dough mixing properties. Lee was best in protein content averaging 0.7 to 0.9 percent higher than the other varieties. The loaf volumes were about the same for the 5 wheats. Mida was best of the samples in flour yield followed by Selkirk. All the varieties milled satisfactorily.

ND 81 x Lee (ND 137-2) produced about the yield of flour expected from a wheat having a test weight of 58.5 pounds. The milling characteristics of the samples from Langdon and Edgeley were only fair. The ash content of the flour from ND 137-2 averaged highest of the North Dakota samples exceeding those of the named varieties grown under comparable conditions. The loaf volume of the bread was lower than expected for the protein content of the flour. ND 137-2 averaged highest in protein content, exceeding Thatcher and Conley, but was slightly lower than Lee. It appears to be a high protein strain. It was one of the highest in absorption and similar to Lee in this respect. The crumb color the bread was medium and similar to that of Thatcher but poorer than that obtained from Lee, Conley, or Mida. The grain of the bread was good and about like that from Thatcher, Mida, and Lee. The dough properties according to the mixogram tests were satisfactory and similar to Conley.

ND 81 x Conley (ND 153) appears similar to Mida for most of the characteristics for which comparisons have been made. The one exception to this was the deficient milling properties of the Langdon, North Dakota, sample. The flour was difficult to remove from the bran and the middlings milled poorly. The samples from the other 3 stations milled satisfactorily. One favorable property of this strain was the satisfactory grain of the bread. The absorption was medium and similar to Selkirk. The loaf volume was about that expected for the protein content of the flour and the crumb color of the bread was slightly better than that made from Thatcher. The dough-handling properties of ND 153 were strong, elastic, and pliable. The flour milled from ND 153 required a fairly high amount of oxidation (potassium bromate) for optimum results. The dough-mixing characteristics (mixing time and tolerance) were strong and similar to the properties found in Conley. This is a promising bread wheat strain.

Lee x ND 34 (ND 138-1) milled satisfactorily and produced a slightly lower yield of flour than expected for a sample of this test weight. This strain appears similar to Lee for most of the characteristics for which comparisons have been made. The dough-handling properties were strong, elastic, and pliable, and the water absorption was high. This strain required slightly less oxidation for optimum results than a number of other strains. It was similar to Selkirk and Conley in this respect. The loaf volume was about that expected for the protein content of the flour. The grain of the bread was satisfactory and the crumb color as good as the bread from a number of the approved hard red spring wheats. The mixogram pattern for ND 138-1 shows that this strain had shorter dough development and tolerance times than the typical good bread wheats. The mixing tolerance of the ND 138-1 samples from Langdon, Minot, and Edgeley were particularly short.

Comparable milling and baking tests of 4 samples of the recently named Canadian variety Pembina (C.T. 229 - R.L. 2814) show that the protein content was high and similar to Lee and the flour ash content about medium. These wheats, with the exception of the sample from Fargo, North Dakota, milled satisfactorily and produced about the yield of flour expected for their test weights. The Fargo sample milled with difficulty. The bran was tough. The flour was hard to remove from the bran and the middlings reduced poorly. The absorption was medium high and the oxidation requirements for the best bread were similar to that of Conley. The dough-handling characteristics were strong, pliable, and elastic. Pembina had the strongest dough-mixing properties according to the mixogram tests of the samples from the North Dakota stations. It averaged longer in development time and tolerance than Conley, Selkirk, and Lee. The loaf volume of the bread was about that expected for the flour protein content of the samples. The bread crumb color was about the same as that from Thatcher and the crumb grain the same as that in the bread made from Conley.

Canthatch (C.T. 233 - R.L. 2936), another Canadian developed variety, was very similar to Pembina for most of the characteristics for which comparisons have been made except for protein content and dough-mixing properties. R.L. 2936 was lower than Pembina in protein content and only slightly shorter in dough-mixing properties. According to the mixogram tests, Canthatch was the third strongest wheat in dough mixing properties of the North Dakota samples. The loaf volume of the bread was about that expected for the protein content of the flour and the crumb grain was good. The milling characteristics of the wheat were satisfactory.

Comparable chemical, milling, and baking tests of II-44-29 x Lee[3] (II-53-541) show that it was very similar to Canthatch in quality. II-44-541 milled satisfactorily, producing a high yield of flour of medium low ash content. The dough-handling properties at the time of panning were strong, elastic, and pliable. It was one of the highest in absorption and very similar to Lee in this respect. The loaf volume of the bread was satisfactory for the protein content of the flour, and the grain of the bread very good. Average figures from the mixogram tests show that this strain has a long development time and tolerance. This is one of the stronger wheats in dough-mixing properties of the comparably tested samples from the North Dakota sation.

Tests made on a single sample of ND 81 x Lee (ND 137) grown only at Fargo, North Dakota, show that it is very similar to Lee (grown at the same location) for most of the characteristics for which comparisons have been made. ND 137 milled satisfactorily, producing a good yield of flour. The flour ash content was lower than most of the samples from this station. The dough-handling properties at the time of panning were strong, elastic, and pliable. The absorption was medium, and the oxidation requirement was low and about the same as for approved varieties grown at this station. The grain and crumb color of the bread were lower than that of Selkirk, Lee, and Conley. It was the lowest in crumb grain of the samples tested from Fargo, North Dakota. The dough-mixing time was medium and the mixing tolerance was long according to the mixogram tests.

The wheats from Williston, North Dakota, were in generally poor condition, low in test weight, and high in protein. This was related to or responsible for the unfavorable showing they made in some of the quality tests. Test weights ranged from 48.2 to 54.6 pounds and wheat protein contents ranged from 16.8 for Selkirk to 19.8 percent for Canthatch. The flour yields, as would be expected, were low and the ash contents of a number of the samples higher than desired. The loaf volumes were generally lower (about 10 to 25 percent) than expected for the protein content of the flour. Considering the data as a whole, Conley made the best bread, followed by Selkirk, II-44-29 x Lee[3], and Thatcher.

The 6 Dickinson, North Dakota, wheats were similar in quality to the same varieties evaluated in the 4 station tests. II-44-29 x Lee[3] was perhaps best of the samples. The named and approved varieties made satisfactory bread. Selkirk had the lowest loaf volume and Lee the lowest yield of flour.

Uniform Regional Nursery Composite

Twenty-seven wheats from the uniform regional nursery were tested in duplicate for their milling, baking, and chemical properties. These consisted of an eastern composite of grain from 5 stations and a western composite of grain from 10 stations as shown in a footnote to table 2. The results of the quality tests for the eastern and western composites and the averages for both are shown in table 2. The discussion of these samples will be based principally on the averages.

Mixogram curves were made only on the eastern composite samples. Values for the development times and mixing tolerances are shown with the eastern composite data.

When possible, samples with similar quality characteristics have been grouped for purposes of discussion; otherwise, individual evaluations of the varieties and strains have been made.

Some general conclusions should be noted concerning the overall characteristics of this year's nursery samples before discussing the individual varieties. Most of the samples made reasonably good bread with little differences in quality among them. Perhaps the greatest difference between the 2 area composites was in their protein content; the eastern samples were highest. There were some other differences such as test weight, flour yield, ash content, and absorption between the 2 composites, but these were not very great.

Table 2.--Milling, baking, and chemical results on 27 wheats grown in the Uniform Regional Nursery for the Eastern Composite, Western Composite, and the average of the Eastern and Western Composites in 1959.[1/]

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Eastern Composite [2/]																	
Marquis	3641	57.0	31	15.9	15.2	73.8	.52	65	2.50	68	2	885	90	100	965	3.50	2.25
Thatcher	10003	57.7	28	15.8	15.2	74.8	.55	66	2.50	67	2	918	80	95	965	3.00	3.00
Selkirk	13100	56.1	32	16.2	15.7	75.2	.58	68	2.50	67	2	878	80	95	990	2.75	2.50
Lee	12488	59.4	31	16.3	16.0	75.3	.60	69	2.75	66	2	865	95	90	1005	3.25	2.50
Conley	13157	57.4	30	17.3	15.4	74.0	.55	67	2.75	69	2	885	90	100	975	3.75	3.75
Henry[1] x P.I. 94587	13457	59.6	35	15.3	14.5	77.6	.56	66	2.50	68	2	895	80	90	930	2.75	2.00
Conley x ND 40-2	13462	59.3	34	17.2	16.3	75.3	.56	69	3.00	70	2	928	90	95	1020	3.50	3.00
Lee x ND 34	13322	60.6	32	15.9	15.0	75.5	.59	70	2.50	66	2	858	90	100	955	2.50	1.75
ND 4 x Lee	13324	58.3	36	16.9	16.0	74.7	.64	70	2.50	69	2	870	85	90	1005	2.75	2.00
ND 81 x Lee	13349	59.3	32	16.8	16.1	74.7	.68	71	3.25	67	2	913	75	85	1010	3.25	2.50
K338AA x N. 2350	13350	60.0	30	16.9	16.6	75.0	.65	71	3.25	69	1	965	85	90	1035	3.25	3.75
ND 5 x ND 36	13460	60.0	39	16.8	16.1	76.1	.55	68	2.50	72	2	965	80	100	1010	2.75	2.00
Lee x ND 34	13461	60.3	31	16.4	15.9	75.4	.62	69	2.75	68	2	905	85	100	1000	3.00	2.25
ND 81 x Conley	13451	61.4	30	15.6	15.5	75.6	.55	71	2.75	66	2	890	85	100	980	2.75	2.00
Ditto	13452	59.5	29	16.7	15.1	74.3	.62	70	3.25	65	2	918	80	95	960	3.50	3.50
(Lee x ND 81sib) x Lee	13453	59.0	32	17.0	16.0	73.8	.58	70	3.25	64	1	915	75	95	1005	3.25	3.50
II-44-29 x Lee[3]	13408	58.8	32	16.9	16.1	75.0	.61	68	3.75	69	2	885	70	95	1010	4.00	4.00
Lee x Kenya Farmer	13454	60.8	29	16.3	15.1	75.8	.56	70	2.75	64	2	890	70	100	960	3.00	1.50
II-44-29 x Lee[2]	13455	59.0	32	15.7	14.6	75.3	.51	69	3.00	67	2	858	70	90	935	3.75	4.00
II-44-29 x Lee[3]	13456	58.8	31	15.8	15.3	75.0	.56	70	3.00	69	2	883	70	90	970	4.50	5.50
Ditto	13415	58.8	33	15.9	15.1	75.6	.53	69	3.00	69	2	883	75	100	960	4.50	4.50
Ditto	13458	59.3	32	15.4	14.9	74.8	.51	69	2.50	69	2	850	75	95	950	5.00	5.25
Ditto	13459	59.5	32	16.1	15.1	76.0	.52	70	3.25	68	2	875	75	90	960	4.75	4.50
Ditto	13416	59.0	33	16.1	15.3	75.7	.53	71	2.75	70	2	868	75	100	945	4.00	3.75
Pembina (CT 229)	13332	57.4	29	16.4	15.8	72.9	.57	70	2.75	72	2	933	75	90	995	4.50	4.25
Canthatch (CT 233)	13345	58.4	28	16.2	15.2	74.6	.58	72	2.50	66	2	995	75	95	965	3.00	3.00
Reward x C.I. 12632	13406	59.4	32	17.1	16.3	75.2	.58	70	3.00	64	1	925	80	90	1020	4.75	2.75

Table 2.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb		
													Color	Grain	
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.
						Western Composite 3/									
Marquis	3641	57.6	28	15.2	14.6	75.2	.52	67	2.00	67	2	868	80	100	935
Thatcher	10003	58.4	30	15.4	15.0	75.8	.55	68	2.00	67	2	905	75	95	955
Selkirk	13100	57.0	32	15.1	14.6	75.6	.48	67	2.25	67	2	855	80	95	935
Lee	12488	58.9	33	16.1	15.1	74.4	.52	70	2.00	63	3	950	80	100	960
Conley	13157	57.3	33	15.7	15.0	75.0	.48	68	2.00	69	2	898	80	100	955
Henry[7] x P.I. 94587	13457	59.4	35	14.7	13.8	77.8	.48	66	1.75	67	2	870	75	90	895
Conley x ND 40-2	13462	58.5	35	16.5	15.6	75.4	.45	67	2.50	71	2	920	95	85	985
Lee x ND 34	13322	59.2	33	15.5	14.4	75.0	.50	67	2.00	62	2	878	80	85	925
ND 4 x Lee	13324	58.3	36	16.4	15.2	75.0	.56	68	2.00	69	2	890	80	95	965
ND 81 x Lee	13349	58.4	33	16.2	15.3	73.0	.58	67	2.25	67	2	908	75	90	970
K338AA x N. 2350	13350	59.3	29	16.2	15.0	74.3	.55	67	2.50	69	2	955	90	95	955
ND 5 x ND 36	13460	59.2	38	16.2	15.3	75.1	.50	65	2.00	73	2	955	75	95	970
Lee x ND 34	13461	60.1	33	16.1	15.0	75.2	.59	67	2.00	65	1	925	75	100	955
ND 81 x Conley	13451	60.1	30	15.8	14.7	75.8	.53	68	2.00	61	1	918	80	100	940
Ditto	13452	58.1	30	15.5	14.9	74.3	.61	67	2.25	61	2	920	85	95	950
(Lee x ND 81 sib) x Lee	13453	58.4	32	16.3	15.3	74.7	.61	67	2.25	65	2	950	85	95	970
II-44-29 x Lee[3]	13408	58.7	37	16.4	15.2	75.7	.56	67	2.75	70	2	933	80	85	965
Lee x Kenya Farmer	13454	60.2	29	16.1	14.8	76.5	.56	67	2.00	56	2	885	65	85	945
II-44-29 x Lee[2]	13455	59.5	34	15.8	14.8	75.9	.51	66	2.25	67	2	848	75	95	945
II-44-29 x Lee[3]	13456	59.0	33	15.6	14.5	76.3	.53	66	2.25	70	2	855	85	95	930
Ditto	13415	58.6	35	15.8	14.9	76.9	.53	66	2.50	68	1	868	85	100	950
Ditto	13458	59.5	34	15.9	14.9	74.7	.53	67	2.25	70	2	858	75	95	950
Ditto	13459	59.7	34	15.6	14.5	74.6	.48	66	2.25	68	1	810	75	90	930
Ditto	13416	58.5	33	15.7	14.6	75.9	.53	66	2.50	70	2	868	80	95	935
Pembina (CT 229)	13332	57.2	31	16.1	15.6	73.8	.54	66	2.75	75	2	850	85	90	985
Canthatch (CT 233)	13345	59.0	28	15.9	15.1	73.6	.52	67	2.00	68	1	925	75	100	960
Reward x C.I. 12632	13406	59.6	31	16.0	14.8	73.4	.55	64	2.00	70	2	855	80	90	945

Table 2.—(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain	
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.
						Averages of the Eastern and Western Composites									
Marquis	3641	57.3	30	15.6	14.9	74.5	.52	66	2.25	67.5	2.0	876	85	100	950
Thatcher	10003	58.1	29	15.6	15.1	75.3	.55	67	2.25	67.0	2.0	911	77	95	960
Selkirk	13100	56.6	32	15.7	15.2	75.4	.53	68	2.38	67.0	2.0	867	80	95	963
Lee	12488	59.2	32	16.2	16.0	74.9	.56	70	2.38	64.5	2.5	907	88	95	982
Conley	13157	57.4	32	16.5	15.6	74.5	.52	68	2.38	69.0	2.0	891	85	100	965
Henry[1] x P.I. 94587	13457	59.5	35	15.0	14.2	77.7	.52	66	2.13	67.5	2.0	882	77	90	913
Conley x ND 40-2	13462	58.9	34	16.9	16.0	75.4	.51	68	2.75	70.5	2.0	924	92	90	1003
Lee x ND 34	13322	59.9	32	15.7	14.7	75.2	.54	69	2.25	64.0	2.0	868	85	93	940
ND 4 x Lee	13324	58.3	36	16.6	15.6	74.9	.60	69	2.25	69.0	2.0	880	82	92	985
ND 81 x Lee	13349	58.9	32	16.5	15.7	73.8	.63	69	2.75	67.0	2.0	910	75	87	990
K338AA x N. 2350	13350	59.7	30	16.8	15.8	74.7	.60	69	2.88	69.0	1.5	960	87	92	995
ND 5 x ND 36	13460	59.6	38	16.5	15.7	75.6	.52	67	2.25	72.5	2.0	960	77	97	990
Lee x ND 34	13461	60.2	32	16.3	15.4	75.3	.61	68	2.38	66.5	1.5	915	80	100	977
ND 81 x Conley	13451	60.7	30	15.7	15.1	75.7	.54	70	2.38	63.5	1.5	904	82	100	960
Ditto	13452	58.8	30	16.1	15.0	74.3	.62	69	2.75	63.0	2.0	919	82	95	955
(Lee x ND 81 sib) x Lee	13453	58.7	32	16.7	15.7	74.3	.60	69	2.75	64.5	1.5	933	80	95	988
II-44-29 x Lee[3]	13408	58.8	35	16.6	15.6	75.4	.58	68	3.25	69.5	2.0	904	75	90	987
Lee x Kenya Farmer	13454	60.5	29	16.2	15.0	76.2	.56	69	2.38	60.0	2.0	888	67	93	957
II-44-29 x Lee[2]	13455	59.3	33	15.8	14.7	75.6	.51	68	2.63	67.0	2.0	853	72	92	940
II-44-29 x Lee[3]	13456	58.9	32	15.7	14.9	76.9	.55	68	2.63	69.5	2.0	869	78	92	950
Ditto	13415	58.7	34	15.8	15.0	76.2	.53	68	2.75	68.5	1.5	876	80	100	955
Ditto	13458	59.4	33	15.6	14.9	74.8	.52	68	2.38	69.5	2.0	854	75	95	950
Ditto	13459	59.6	33	15.8	14.8	75.3	.50	68	2.75	68.0	1.5	842	75	90	945
Ditto	13416	58.8	33	15.9	15.0	75.8	.53	68	2.63	70.0	2.0	868	77	97	940
Pembina (CT 229)	13332	57.3	30	16.3	15.7	73.3	.56	68	2.75	73.5	2.0	892	80	90	990
Canthatch (CT 233)	13345	58.7	28	16.1	15.2	74.1	.55	69	2.25	67.0	1.5	960	75	97	962
Reward x C.I. 12632	13406	59.5	32	16.6	15.6	74.3	.57	67	2.50	67.0	1.5	890	80	90	983

1/ See text for methods and moisture basis for various quality determinations.
2/ Composite of seed from Madison, Crookston, St. Paul, Morris, and Brookings stations.
3/ Composite of seed from Dickinson, Minot, Fargo, and Casselton, N. D.; Fort Collins, Colo.; Sheridan and Laramie, Wyo.; Havre, Moccasin, and Sidney, Mont. stations.

The samples were relatively high in protein content with a number of them testing over 16.0 percent. These varieties, as a group, produced exceptional bread in grain, with some better than others. It is of interest that of the 27 wheats, 5 of them made bread scoring 100 and 9 others scored 95 and 97 in crumb grain. This is an excellent showing and encouraging proof of some of the satisfactory parent material being used in the hard red spring wheat breeding program. About half of the samples made bread scoring 78 or lower in crumb color. The crumb of these was yellow and not so white as those scoring 85 and higher in color. One of the promising characteristics of a number of the strains was their strong dough properties (development time and mixing tolerance) according to the mixogram tests. Many of the strains also had strong dough characteristics at the time of panning, indicating a satisfactory quality property in a bread flour. In general, the flour from this year's nursery samples was stronger (tougher) in gluten properties than last year's samples. They required somewhat longer mixing times for proper development and have longer mixing tolerances in comparison with the previous year's samples. The yield of flour was exceptionally high for a number of the strains, considering the test weight of the wheats.

The approved hard red spring varieties Marquis, Thatcher, Selkirk, Lee, and Conley made satisfactory bread. Conley was perhaps the strongest of these, with Marquis next best and nearly as good in quality. Both produced a satisfactory yield of flour of relatively low ash content. The mixogram pattern for Conley was strong, showing a relatively long development time and mixing tolerance. The dough-handling properties of the 5 varieties at the time of panning were good, being strong, elastic, and pliable.

Henry[7] x P.I. 94587 (Wis. 253) milled satisfactorily, producing an exceptionally high yield of low ash flour. This strain was the highest in flour yield of the comparably-grown wheats. The pearling index value indicated that Wis. 253 is a slightly softer wheat than Thatcher. The absorption was medium and was the same as Marquis. The loaf volume of the bread was about that expected for the flour protein content, and the internal bread properties were similar to those of Thatcher. The dough properties (development time and mixing tolerance) were about medium and very similar to those of Selkirk.

Comparable quality tests of Conley x ND 40-2 (ND 102) show that it is similar to Conley for most of the characteristics for which comparisons have been made. ND 102 was higher in test weight and the loaf volume of the bread was a little higher than that of Conley. The internal characteristics of the bread were good and the dough-handling properties at the time of panning were strong, elastic, and pliable.

Lee x ND 34 (ND 81) was very similar to Lee in quality with possibly 2 exceptions. ND 81 was 1.3 percent lower in flour protein content, and was shorter in development time and mixing tolerance than Lee. The doughs of ND 81 at the time of panning were elastic and pliable.

ND 4 x Lee (ND 90-5) milled only fair. According to the pearling index, the grain was slightly softer than the approved hard red spring varieties. The flour yield was relatively high for the test weight of the sample. ND 90-5 produced flour of high ash content exceeding that of both Marquis and Lee. The dough properties according to the mixogram tests were not quite as strong as those of the comparably grown samples of Lee. The internal characteristics of the bread were medium good but the loaf volume was about 11.0 percent lower than expected for the protein content of the flour.

Tests of ND 81 x Lee (ND 137) show that it was very similar to Lee for most of the characteristics for which comparisons have been made. The only exceptions were the ash content of the flour which was much higher and crumb color of the bread which was 13 points lower than that of Lee. The dough-mixing time in the bread-making process was extremely long and the dough-handling properties strong, elastic, and pliable. The quality of the doughs, according to the mixogram test, indicated strong properties.

The milling characteristics of K338AA x N 2350 (ND 140) were only fair and the ash content of the flour was higher than that of the comparably grown samples of Marquis, Thatcher, and Conley. This strain produced bread satisfactory in loaf volume and internal characteristics. It was one of the better wheats in dough properties according to the mixogram tests. Both the development time and the mixing tolerance were long and like Conley in this respect. ND 140 required about 25 percent less oxidation for optimum bread than the other wheats from the nursery trials.

ND 5 x ND 36 (ND 125) milled satisfactorily, producing a good yield of low-ash flour. The pearling index indicates that the grain of ND 125 is softer than the comparably grown grain of Thatcher, Conley, or Lee. The loaf volume of the bread was about that expected for the flour protein content, crumb color about medium, and the grain of the bread excellent. The quality of the dough according to the mixogram test was medium and very similar to that of Selkirk.

Tests of Lee x ND 34 (ND 138-1) show that it was very similar to Lee for most of the characteristics for which comparisons have been made. The exceptions to this were the higher flour ash content and better grain but slightly poorer crumb color of the bread than that of Lee. ND 138-1 required about 40 percent less oxidation for optimum bread than Lee. The dough-handling properties of ND 138-1 at the time of panning were good, being elastic and pliable.

Comparable milling and baking tests of the 2 strains ND 81 x Conley (ND Nos. 152 and 153) show that each differed in some respects from Conley. Selection ND 152 had a higher test weight in the grain, greater yield of flour, slightly lower protein content, and a better absorption than Conley. It required 25 percent less oxidation for optimum bread and the development time and mixing tolerance were not so strong as those of Conley. Selection ND 153 was very similar to Conley for most of the comparable tests made, with one possible exception. The ash content of the flour was somewhat higher than that of Conley. The dough-mixing and handling properties were strong and the loaf volume was about that expected for the protein content of the flour. Considering the data as a whole, ND 152 appears to be the stronger in quality of the 2, but the differences were not very great.

Lee x Kenya Farmer (II-52-52) appears to be similar to Lee for many of the quality characteristics compared. The only exceptions to these were the higher ash content, lower crumb color of bread, and shorter dough-mixing tolerance. Lee x Kenya Farmer required about 40 percent less oxidation for optimum bread than Lee.

Seven selections from a cross II-44-29 x Lee and backcrosses to Lee were tested for quality. One of the most significant and promising quality properties of the selections from this cross was their very strong dough characteristics as shown by the long development time and mixing tolerance. All of the selections were better in this respect than Lee. The best of the samples was perhaps II-44-29 x Lee^3 (sel. II-53-562), with sel. Nos. II-53-532, -541, and -565 nearly as strong in dough quality properties. Those next best in dough properties were II-44-29 x Lee^2 (II-52-74) and II-44-29 x Lee^3 (sel. Nos. II-53-546 and -567). The longer development time and mixing tolerance properties of these strains account in part for the satisfactorily strong, elastic, and pliable doughs at the time of panning. As a group, the selections from the cross II-44-29 x Lee and backcrosses to Lee milled satisfactorily and produced a good yield of flour. The ash contents of the flours were somewhat lower with the exception of sel. No. II-53-546 which was slightly higher than that of Lee. There was some variation in protein content among the samples with a greater spread between the wheat and flour in some samples than that in Lee. The crumb color of the bread from the wheats as a group was lower and the bread grain about the same as in the bread from Lee. The loaf volumes of the bread were about that expected according to the protein content of the flours, with 2 possible exceptions. These were Selection Nos. II-53-562 and -565, which produced moderately lower loaf volumes according to the flour protein than the others. It is interesting that the eastern composite strains have generally produced higher loaf volumes than Lee when considering the flour protein content of the crosses. This fact is evidence of the better gluten quality of the strains than that of Lee. Lee generally produces a lower loaf volume than expected according to the flour protein content, indicating a slightly poorer gluten quality than that of Thatcher, Conley, Mida, or Marquis. Considering the data as a whole, Selection Nos. II-53-541, and -567 appear to be the strongest.

Pembina (C.T. 229) was similar to Thatcher for most of the quality characteristics for which comparisons have been made. It was a little higher in protein content and lower in yield of flour and produced flour having about the same ash content as that from Thatcher. In milling, the flour was found difficult to remove from the bran according to the single sample tested. C.T. 229 produced satisfactory bread. The dough properties (development time and mixing tolerance) were moderately stronger than those of Thatcher.

Canthatch (C.T. 233) was very similar to Thatcher in quality. Both samples produced flour of about the same protein content. The dough of C.T. 233 at the time of panning was elastic and pliable. Canthatch required about 25 percent less oxidation for optimum bread than Thatcher.

Comparable quality tests of Reward x C.I. 12632 (Wis. 251) show that it was very similar to Lee in quality. The only exceptions to this were the lower absorption and crumb color of bread. The quality of the dough according to the mixogram tests show that Wis. 251 had a moderately longer development (mixing) time but about the same mixing tolerance as Lee. The doughs at the time of panning were bucky, an objectionable property, rather than mellow, pliable or elastic -- quality characteristics preferred for the production of pan bread. The oxidation requirements of Wis. 251 were about 25 to 40 percent less than those of the approved hard red spring wheats. This is a favorable property of the strain.

(Lee x ND 81 sib.) x Lee (ND 162) was very similar to Lee for most of the quality characteristics for which comparisons have been made. The only exception to this was the ash content of the flour, which was higher, and the dough-mixing time, which was slightly longer than that of Lee. ND 162 made satisfactory bread of good loaf volume, crumb color, and grain. The dough-handling characteristics at the time of panning were strong. It required about 40 percent less oxidation for optimum bread than Lee.

State Nursery Trials

Results for the samples grown in the Montana State Nursery trials are shown in table 3. These include samples on composites of a number of varieties and strains grown in the Yield Nursery at Moccasin, Sidney (dry), and Havre; Advanced Yield Nursery at Moccasin, Sidney (dry), and Huntley (dry); and from the Sawfly Yield Nursery at Moccasin, Sidney (dry), and Dutton, Montana.

Yield Nursery

Moccasin, Sidney (dry), and Havre, Montana

The varieties and strains for this Montana composite have been evaluated to a considerable extent on a consideration of the quality data as a whole. A number of the samples made exceptionally satisfactory bread.

Table 3.--Milling, baking, and chemical results on hard red spring wheats grown in State nursery trials, 1959 crop.[1/]

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Montana Yield Nursery [2/]																	
Rescue-N1315 x G. Ball	B57-170	55.4	34	16.5	15.6	72.0	.58	64	1.75	70	2	918	65	95	985	2.25	1.50
Ditto	-157	56.5	30	16.3	15.4	71.2	.54	65	2.00	71	1	910	70	95	975	3.25	1.50
Ditto	-175	54.8	34	15.8	15.7	74.8	.60	65	2.50	71	2	935	65	80	990	3.25	1.50
Thatcher[2] x Rescue	-194	57.7	29	17.1	16.3	72.5	.51	71	2.00	70	2	935	75	90	1020	2.25	1.50
Rescue-N1315 x G. Ball	-102	56.8	31	16.2	15.7	72.5	.52	65	2.75	68	2	913	65	85	990	3.50	1.75
Ditto	-176	56.0	32	16.5	16.1	71.5	.57	68	2.50	35	2	923	75	85	1010	3.00	1.25
Ditto	-172	55.8	32	16.3	15.8	72.6	.57	64	2.50	60	2	893	75	85	995	3.25	1.50
Ditto	-127	57.9	32	16.3	15.6	72.1	.55	64	2.50	71	1	950	75	95	985	2.75	1.25
Ditto	-100	57.7	31	16.0	15.5	71.3	.54	66	2.25	74	2	925	70	90	980	3.50	1.50
Thatcher[4] x Rescue	-213	57.7	28	16.6	15.9	71.7	.55	70	2.25	73	2	938	75	100	1000	2.25	1.25
Rescue-N1315 x G. Ball	-81	59.1	34	15.8	15.5	74.4	.57	64	2.50	75	2	933	65	95	980	2.75	1.25
Thatcher[4] x Rescue	-211	57.7	28	16.7	15.8	72.9	.55	69	2.25	67	2	925	70	95	995	2.50	1.50
Rescue-N1315 x G. Ball	-69	59.9	36	15.9	15.3	74.2	.55	64	2.25	68	2	843	70	95	970	2.50	1.25
Thatcher	10003	57.8	30	16.7	16.1	75.2	.57	64	2.00	75	2	880	85	90	1010	2.50	1.50
Rescue-N1315 x G. Ball	B57-103	57.1	32	16.3	15.6	72.4	.53	64	2.75	75	2	907	80	85	985	3.25	1.75
Ditto	-149	58.5	33	16.6	15.6	73.4	.55	64	2.75	71	1	915	75	95	985	3.00	1.75
Ditto	-84	58.8	38	16.8	16.1	73.5	.50	64	2.50	74	2	905	75	95	1010	3.25	1.25
Ditto	-4	56.0	37	17.6	16.9	72.3	.52	64	2.00	75	2	905	65	90	1050	2.75	1.25
Ditto	-31	58.0	36	16.3	15.6	74.4	.55	67	2.25	75	2	900	65	95	985	3.25	1.00
Ditto	-153	57.9	38	17.1	16.0	74.0	.61	67	2.50	75	2	945	65	90	1005	3.00	1.25
Ditto	-106	57.8	35	16.7	15.8	73.1	.60	66	2.00	75	2	890	65	90	995	3.00	1.50
Centana	12974	57.6	31	17.1	16.1	75.7	.57	67	2.00	75	2	1035	85	90	1010	2.50	1.50
Thatcher[4] x Rescue	B57-214	58.0	31	17.0	16.1	74.2	.52	68	2.00	75	2	963	80	90	1010	2.75	1.50
Rescue-N1315 x G. Ball	-174	55.5	34	16.7	16.1	74.2	.59	66	2.50	75	1	943	85	90	1010	3.00	1.50
Ditto	-1	55.1	33	16.2	15.9	73.1	.57	68	2.50	75	1	1015	80	85	1000	2.75	1.50

Table 3.--(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Montana Advanced Yield Nursery 3/																	
Rescue	12435	57.8	32	16.5	15.7	71.0	.46	63	2.00	74	2	938	75	85	990	3.00	1.25
Thatcher[2] x Rescue	B57-191	54.9	26	17.3	16.3	69.2	.47	63	2.75	75	2	940	70	85	1020	4.75	2.50
Thatcher	10003	56.4	28	17.3	16.4	71.3	.46	65	2.00	74	1	975	80	90	1025	3.25	1.25
Selkirk	13100	54.4	31	17.3	15.4	74.3	.45	63	2.00	74	2	883	85	90	975	3.50	1.50
Thatcher[3] x Rescue	B57-196	56.1	26	16.8	15.5	71.4	.47	62	2.00	67	2	970	80	85	980	2.75	1.25
Thatcher x Lee	B55-4	56.0	34	17.1	16.4	73.7	.47	62	2.00	71	2	988	80	90	1025	3.25	1.50
Ceres	6900	58.0	25	16.4	15.7	71.7	.47	63	2.25	70	2	930	85	85	990	2.75	2.00
Thatcher x Lee	B55-5	57.5	34	16.7	16.0	74.4	.47	63	2.25	71	1	973	85	95	1005	3.75	2.00
Canthatch (CT 233)	13345	57.1	28	16.9	16.1	73.6	.50	64	2.25	69	1	930	80	90	1010	3.00	1.75
Chinook	13220	59.9	31	16.4	16.0	75.8	.49	65	2.50	68	2	880	85	95	1005	2.75	1.50
Pembina (CT 229)	13332	55.6	31	16.7	16.0	74.5	.54	66	3.00	72	1	920	75	85	1005	4.00	3.00
Lee	12488	57.5	33	17.0	16.2	73.7	.55	66	2.25	69	1	838	85	85	1015	2.25	1.25
Rescue-N1315 x G. Ball	B57-173	53.8	30	16.0	15.1	73.5	.52	65	3.50	71	1	920	75	85	960	4.25	2.25
Centana	12974	56.8	27	17.5	16.5	72.3	.52	65	3.00	72	1	1013	85	85	1030	3.00	1.25
Pilot	11945	56.0	25	17.0	16.0	71.9	.54	65	3.00	72	1	930	85	95	1005	3.00	1.50
Conley	13157	55.0	32	17.5	16.5	73.4	.53	67	2.75	71	2	920	85	90	1030	2.50	1.50
1953 x Lee	13242	57.6	31	15.7	15.1	75.3	.45	64	1.75	69	2	880	90	100	960	2.75	1.50
Sawtana	13304	59.1	30	16.4	16.0	75.0	.50	64	2.00	69	2	900	75	90	1005	3.00	1.25
Rescue-N1315 x G. Ball	B57-92	55.8	29	16.2	15.7	72.4	.50	64	2.50	71	2	918	80	85	990	3.00	1.50
Lake	13413	54.8	29	17.3	16.3	73.4	.51	65	2.00	72	1	973	80	90	1020	2.75	1.25

Table 3.—(Continued).

Variety or Cross	C.I. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
				Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
		Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Montana Sawfly Yield Nursery 4/																	
Rescue x Cadet	13328	56.3	32	15.9	15.0	75.1	.53	65	2.75	75	2	943	90	100	955	4.25	3.00
Rescue-N1315 x G. Ball	13410	56.9	38	15.5	14.4	72.9	.48	64	2.75	75	2	1010	80	100	925	3.00	1.25
Thatcher-K.F. x Rescue	13417	58.1	39	15.4	15.4	74.4	.49	63	3.00	75	2	915	85	95	975	4.25	2.25
Rescue	12435	56.2	31	15.6	15.1	74.7	.48	62	2.75	75	1	948	80	95	960	3.75	1.50
Kendee x H46133	13421	57.2	38	16.1	15.2	75.1	.44	62	3.00	73	2	950	75	90	965	4.00	1.25
Sawtana	13304	57.2	37	15.7	15.0	76.8	.48	66	3.00	69	2	875	70	90	955	3.50	1.75
Thatcher-K.F. x Rescue	13420	57.3	47	15.5	15.0	75.6	.45	65	2.75	72	2	923	75	100	955	2.75	1.25
Thatcher[2] x Rescue	13411	56.8	35	15.8	14.8	74.3	.50	66	2.50	68	2	878	70	90	945	3.25	1.50
Kendee x H46133	13422	57.0	38	15.9	15.2	75.0	.46	66	3.25	75	1	960	65	95	965	3.75	1.75
Rescue x Chinook	13330	57.0	45	16.2	15.8	74.8	.45	66	2.50	75	2	1020	85	100	995	2.75	1.50
Thatcher[4] x Rescue	13412	56.0	34	16.5	15.8	73.1	.47	67	2.50	69	1	985	75	95	995	3.00	1.25
Thatcher-K.F. x Rescue	13418	57.2	45	15.7	15.3	76.4	.47	64	3.00	72	1	978	85	95	970	4.00	1.75
Rescue-N1315 x G. Ball	13409	55.2	41	16.7	15.8	74.6	.50	67	3.00	68	2	965	75	95	995	3.25	1.00
Thatcher-K.F. x Rescue	13419	55.8	44	16.5	15.9	75.9	.53	67	2.25	70	2	958	80	95	1000	3.00	1.00
Chinook	13220	57.5	41	16.3	15.9	77.4	.51	69	2.00	66	2	928	75	95	1000	2.50	1.00
Rescue x Chinook	13344	57.9	41	16.2	15.7	75.7	.49	68	2.75	69	2	938	75	90	990	3.50	1.50
Thatcher	10003	54.8	37	16.6	16.1	74.6	.47	68	2.50	75	2	960	80	95	1010	3.00	1.50

1/ See text for methods and moisture basis for various quality determinations.
2/ Composite seed from Moccasin, Sidney (dry), and Havre stations.
3/ Composite seed from Moccasin, Sidney (dry), and Huntley (dry) stations.
4/ Composite seed from Moccasin, Sidney (dry), and Dutton stations.

All were relatively high in protein content with none lower than 15.3 percent in the flour. The optimum amount of water (absorption) required to bring the dough to the standard consistency in the bread-making process was high for a number of the samples, a favorable property. The dough-mixing times were longer for some of the strains than the approved hard red spring varieties included as standards of comparison. This is a desired characteristic. The flour yields were reasonably high and better in some instances (74.0 percent and above) than expected when considered in relation to the generally low to medium test weights of the wheats. The crumb color of the bread as a group tended to score low, being yellow rather than white, the latter a preferred characteristic. The yellow crumb color is perhaps not too objectionable since it is a common practice to bleach flour to the desired whiteness in the wheat milling process. Crumb color, nevertheless, should be considered in evaluating the wheats for bread. The ash content was high (0.60 and above) for a number of the flours, not a favorable property.

Thatcher^{2} x Rescue (B57-194) made satisfactory bread and in some respects was superior to Thatcher in quality properties. It was higher than Thatcher in protein content, water absorption, and loaf volume. It was low in ash content of flour. Thatcher^{2} x Rescue milled satisfactorily but produced 2.7 percent less flour than Thatcher although both were similar in test weight per bushel. The dough-handling properties of this strain were acceptable, being moderately strong and pliable. The grain of the crumb was equal but the crumb color of the bread was lower than that in the bread from Thatcher.

The 3 selections from Thatcher^{4} x Rescue appear to be good wheats and are very similar in quality. All milled satisfactorily. Sel. No. B57-214 produced the highest yield of flour. One favorable property of the flours from this cross was their low ash content. All 3 samples made good bread. As a group, the water absorptions of the doughs were high, ranging from 68 to 70 percent as compared with 64 percent for Thatcher.

The loaf volumes of the bread were about that expected according to the protein content of the flours. The dough-mixing time was the same for Sel. B57-214 as that of Thatcher and longer for Sel. Nos. B57-213 and -211 than that of Thatcher. The grain of the bread was best (scoring 100) for Sel. B57-213, followed by Sel. B57-211 (scoring 95). Sel. B57-214 was lowest (scoring 90). None of the samples would be considered unsatisfactory in grain of bread. All 3 strains appear to be of good quality for bread. Sel. Nos. B57-213 and -211 are perhaps best of the group in quality, with Sel. 57-214 slightly lower and nearly as good quality wise.

A number of the Rescue-N1315 x Golden Ball crosses have shown more promise as being satisfactory for bread than some of the other wheats from the same cross. Considering the data as a whole, the strains which appeared best in quality were selections B57-127, -100, -103, -157, -149, -174, and -1. These wheats milled satisfactorily and produced a relatively high yield of flour in relation to the test weight of the wheats. The ash content of the flour was about that expected and the absorption high. The dough-mixing times were all satisfactory and longer than that of Thatcher or Centana, which were grown under comparable conditions. The dough-handling properties were strong, elastic, and pliable. Sel. Nos. 57-1, -157, -174, -127, and -149 required the least amount of oxidation for optimum loaf volumes and are the best wheats of the group in this respect. All of these strains produced good bread, having loaf volumes of about that expected for the flour protein content. The crumb color was medium and the grain of the bread good to excellent.

The other Rescue-N1315 x Golden Ball strains would have been more satisfactory in quality for bread had they not been deficient in one or more of their quality properties. In some cases the deficiencies were only minor but should be considered when determining the value of these crosses in relation with the others for increase or discarding. These selections and their deficient quality properties were as follows: Sel. B57-170, because of short dough-mixing time, low bread crumb color, and fair milling properties; sel. no. -175, high flour ash content; sel. nos. -31, -102, and -81 low bread crumb color; sel. no. -176, fair milling properties and lower loaf volume than expected according to the flour protein content; sel. nos. -172 and -69, lower loaf volumes than expected according to the protein content of the flour; and sel. no. -84, lower loaf volume for protein content than expected and pearling index high, indicating a softer textured wheat than the approved hard red spring varieties. Other strains having deficiencies were sel. no. B57-4, because of low bread crumb color, high pearling index, and fair milling properties; sel. no. -153, a low crumb color of bread and high flour ash content; and sel. no. -106, high flour ash content, low bread crumb color, and lower loaf volume than expected according to protein content of flour.

A number of these latter enumerated selections made bread with excellent grain characteristics and exceptionally high flour yields (74.0 percent and higher) in addition to having strong, elastic, and pliable dough properties.

Gluten washing experiments have been made of a number of the Rescue-N1315 x Golden Ball crosses to study further their general dough properties. The glutens were found to be elastic, pliable, and generally similar to the glutens washed from a number of the approved hard red spring varieties. The durum wheats (including Golden Ball) generally produce short, sticky, and weak doughs, an undesirable property of a flour for bread purposes.

According to the mixogram curves made on these samples, most of the crosses and varieties had about the same mixing tolerance times but varied somewhat in their development times. The tolerance times ranged from 1.25 minutes to 1.75 minutes, shorter than the average for the approved spring wheats. The short mixing tolerances indicate a poor or weak stability to mixing, an undesirable property for a commercial bread flour. Development times were somewhat longer with a range from 2.25 minutes to 3.50 minutes. Rescue-N1315 x Golden Ball (B57-170), Thatcher[2] x Rescue (B57-194), and Thatcher[4] x Rescue (B57-213) had the shortest development times (2.25 minutes) with Rescue-N1315 x Golden Ball (sel. nos. B57-175, -102, -172, -100, -103, -84, and -31) longer than 3.00 minutes. Thatcher and Centana had average development times of 2.50 minutes each and both had short mixing tolerances (1.50 minutes each), similar to those of the comparably grown crosses or selections. As a group, the selections from the cross Rescue-N1315 x Golden Ball had slightly longer development times than the group with Thatcher and Rescue as parent wheats.

Advanced Yield Nursery

Moccasin, Sidney (dry), and Huntley (dry), Montana

The small differences in quality among a number of samples made it extremely difficult to rank the wheats. All of the samples produced bread satisfactory in crumb grain, with some better than others. It is of interest that 11 of the 20 samples produced bread scoring 90 or above in crumb grain. This is a fine showing for one of the important bread properties. The crumb color scores varied from low to medium with only 1 of the 20 samples making bread scoring as high as 90 in crumb color. All the samples milled satisfactorily. Those wheats having the best milling properties were Selkirk, Chinook, Thatcher x Lee (B55-5), and 1953 x Lee (B52-91). A number of the wheats produced a high yield of flour averaging 75.0 percent or better. These are some of the more promising wheats among the advanced yield nursery samples.

There was little variation among the samples in wheat and flour protein content, but differences were greater in test weight per bushel. The higher flour protein contents account, in part, for the relatively strong and satisfactory dough characteristics of the samples. None of the samples appeared to be deficient in dough-handling properties. In fact, the flour of some of the varieties and strains is stronger than desired (bucky) and would be ideal for blending with flour from weaker wheats.

The dough-mixing properties were relatively strong for most of the samples. The only exception to this was 1953 x Lee (B52-91), which had the shortest dough-mixing time of the samples compared. Those strains having the longest dough-mixing time, a desired hard red spring quality characteristic now in demand, were Rescue-N1315 x Golden Ball (B57-173) and Thatcher x R.L. 2564 (C.I. 13332). Centana and Pilot also had relatively long dough mixing times. Thatcher[2] x Rescue (B57-191) was nearly equal in dough-mixing time to the above-named varieties.

The approved varieties, Rescue, Thatcher, Selkirk, Ceres, Centana, Pilot, Conley, and Lake, made satisfactory bread. Thatcher and Conley were perhaps strongest in dough-handling properties at the time of panning. Chinook and Lee produced much lower loaf volumes than expected for the protein content of flour, making them somehwat less desirable than the other approved varieties.

The strains that appear to be best in quality, considering the data as a whole, were Thatcher x Lee, sel. nos. B55-4 and -5 and Canthatch. All of these wheats had good dough-handling properties, and the bread was satisfactory in loaf volume, grain, and crumb color. The dough-mixing time was medium long, flour ash content low, and the absorption high. Two of the flours, Canthatch and Thatcher x Lee (B55-5), required only half the amount of oxidation (potassium bromate) required for either Rescue or Conley. This is a favorable property.

Those next best and nearly as good as the above-named wheats were Thatcher[3] x Rescue (B57-196) and Rescue-N1315 x Golden Ball (sel. nos. B57-173 and -92). These made bread that scored 85 in bread crumb color but this is perhaps not too important since it is common practice to bleach flour. Two favorable properties of sel. no. B57-173 were its long dough-mixing time and high flour yield. Sel. no. B57-196 was lowest of the 3 in flour ash content.

It is interesting that the dough made from the flour where Golden Ball was one of the parents in the wheat cross is not sticky. This is frequently a property of the flour made from durum wheats.

A number of the other strains would have been more promising for bread if they had not been deficient in one or more of their quality properties. These strains and their lower quality property or properties are as follows: Thatcher[2] x Rescue (B57-191), slightly low flour yield and low in bread crumb color; Thatcher x R.L. 2564 (C.I. 13332), high in flour ash content and slightly lower in loaf volume as compared to that expected according to the flour protein content. The favorable characteristic of these 2 strains are their relatively long dough-mixing properties and their strong, elastic, and pliable dough-handling properties at the time of panning.

The recently named Montana variety Sawtana (C.I. 13304) would have rated higher except for its low bread crumb color and lower than expected loaf volume according to the protein content of the flour.

1953 x Lee (B52-91) was one of the highest in yield of flour, lowest in ash content of flour, and produced bread having the best crumb grain and color of the samples tested. The dough-mixing time was shorter than that of Centana or Rescue. The dough-handling properties of this one sample were mellow, elastic, and slightly on the weak side.

Mixogram curves have been made on the flour composited by variety from the 20 advanced yield nursery samples. The results of these tests show that there were some differences in the dough characteristics. The mixogram patterns for most of the samples showed reasonably satisfactory development times but shorter mixing tolerance times as compared with the wheats grown in the different state plot trials. Even the mixing tolerance times for the approved and named varieties were shorter than normally expected. It is difficult to account for this behavior since these varieties were high in protein content and their dough properties at the time of panning were generally strong. Ceres showed the strongest dough properties according to the mixogram tests on the long time approved and named varieties. The recently named Canadian variety, Pembina, was one of the strongest in dough-mixing properties, exceeding the approved varieties included as standards of comparison. There were a number of strains that showed good dough quality according to the development times and mixing tolerances. These were as follows: Thatcher^2 x Rescue (B57-191), Thatcher x Lee (B55-5), and Rescue-N1315 x Golden Ball (B57-173).

Sawfly Yield Nursery

Moccasin, Sidney (dry), and Dutton, Montana

The varieties and strains for this Montana composite have been evaluated to a considerable extent on a consideration of the quality data as a whole. A number of the samples made exceptionally satisfactory bread.

All the wheats were relatively high in protein content, with none lower than 14.8 percent in the flour. The optimum amount of water (absorption) required to bring the dough to the standard consistency in the bread-making process was exceptionally high for a number of the samples. This is one of the favorable properties of these strains and varieties. The dough-mixing times were longer (3.00 minutes or better) for some of the strains than the approved Thatcher, Rescue, or Chinook. This is a favorable characteristic. The flour yields were exceptionally high and better in some instances (75.0 percent and above) than expected when considered in relation to the generally low to medium test weights of the wheats. All of the wheats milled satisfactorily with most of them having very good milling characteristics. These samples made generally very acceptable bread with medium to good crumb color, excellent crumb grain, and high loaf volumes. The loaf volumes of the bread were about that expected according to the protein content of the flour.

Considering the data as a whole, the strains that appear to be best in quality for bread were Rescue x Cadet (C.I. 13328), Thatcher-K.F. x Rescue (C.I. 13417), Thatcher[4] x Rescue (C.I. 13412), Rescue-N1315 x Golden Ball (C.I. 13409 and -10), and Thatcher-K.F. x Rescue (C.I. 13419). Rescue and Thatcher were also of satisfactory quality for bread. All these samples were considered acceptable in milling properties, produced about the yield of flour expected for the test weights of the wheats, and gave medium low ash content. The dough-handling characteristics were strong, elastic, and pliable. The dough-mixing times were long, with samples C.I. nos. 13417 and 13409 longest and best in the group in this respect. In the bread tests the absorption was good to excellent (varying from 62.0 to 68.0 percent), loaf volumes about that expected for the protein content of the flour, bread grain excellent (scoring 95 to 100), and the crumb color medium to very good. The low crumb color of the bread is perhaps not too objectionable since it is general practice to bleach flour to the desired color in the wheat milling process. Rescue and Thatcher[4] x Rescue (C.I. 13412) required the least amount of oxidation (potassium bromate) in the bread-making process for optimum loaf volumes, which is considered a favorable property of the flour for bread.

A number of the other strains would have been equally satisfactory for bread if they had not been deficient in one or more of their quality properties. In some instances these deficiencies are not very great but, nevertheless, are important and should be given consideration in choosing the strains that will best meet the needs of the industry. These strains and their lower quality properties are as follows: Kendee x H46133 (C.I. 13421), Thatcher[2] x Rescue (C.I. 13411), and Sawtana (C.I. 13304), slightly low crumb color and grain of bread; Rescue x Chinook (C.I. 13344), low bread crumb color; Thatcher-K.F. x Rescue (C.I. nos. 13420 and 13418) and Rescue x Chinook (C.I. 13330), high pearling index values indicating softer textured wheat than the approved hard red spring varieties; Kendee x H46133 (C.I. 13422), poor bread crumb color; and Chinook, slightly short dough-mixing time and sticky dough-handling properties.

A number of these strains have some favorable and outstanding quality properties that should be pointed out. These are: C.I. nos. 13421 and 13422, long dough-mixing times and low flour ash content; C.I. nos. 13418 and 13304, high flour yields and long dough-mixing times; C.I. nos. 13420 and 13330, low flour ash content; Chinook, high yield of flour and absorption; and C.I. 13344, high water absorption.

Mixogram curves were made on these samples for additional quality data. Most of them had moderate to long development times but only short to average mixing tolerances. The only exception was Rescue x Cadet (C.I. 13328) with a development time of 4.25 minutes and a mixing tolerance of 3.00 minutes. The rest of the samples in this group had mixing tolerance times ranging from 1.00 minutes to 1.75 minutes except for Thatcher-K.F. x Rescue (C.I. 13417) with a tolerance of 2.25 minutes. There was considerably more variation between samples in the amount of time required for optimum development. The curves showed development times ranging from 2.50 to 4.25 minutes. The one sample having the longer time, other than Rescue x Cadet, was Thatcher-K.F. x Rescue (C.I. 13417). Development times of 4.00 minutes were obtained on the curves for Kendee x H46133 (C.I. 13421) and Thatcher-K.F. x Rescue (C.I. 13418), Thatcher-K.F. x Rescue (C.I. 13420), Rescue x Chinook (C.I. 13330), and Chinook had the shortest development times of 2.75, 2.75, and 2.50 minutes, respectively. The 3 approved varieties were in the intermediate group, for the most part, with Chinook appearing to be the weakest by a slight margin with a 2.50 minute development time and 1.00 minute tolerance. Thatcher and Rescue were similar with development times of 3.00 and 3.75 minutes and mixing tolerances of 1.50 and 1.50, respectively.

Commercial Samples

As in past years, a number of commercially grown wheat samples were obtained through the Grain Division, Agricultural Marketing Service, for comparison with the varieties and strains produced in experimental plots. Twenty-eight such samples representing a number of grades and subclasses were obtained at Great Falls, Montana, and Minneapolis and Duluth, Minnesota. The samples were composited by grade from 2380 cars of wheat grading No. 5 or better. This is the twenty-first season such samples have been tested. The results are given in table 4.

These samples generally averaged lower in protein content than the varieties and strains grown in experimental plot and nursery trials. The Minneapolis and Duluth, Minnesota, wheat samples averaged 14.3 and 14.4 percent, respectively; the Great Falls, Montana, samples were somewhat higher, averaging 15.0. The milling characteristics were much alike for the commercial and experimental samples, with the commercial samples possibly slightly higher in yield of flour on the average. The baking and chemical results do not appear to be greatly different when compared with samples having approximately the same protein content.

able 4.--Milling, baking, and chemical results on 28 composite commercial samples from 2,380 cars of hard red spring wheat obtained at Duluth, Great Falls, and Minneapolis, representing the 1959 crop.1/

Location where Obtained	U. S. Grade	No. of cars	Test weight	Pearling index	Protein		Flour yield	Flour ash	Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests	
					Wheat	Flour						Bromate	Loaf volume	Crumb color	Crumb grain		Development time	Mixing tolerance
			Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
uluth, Minn.	1HDNS	72	60.2	31	14.4	13.7	77.4	.55	63	2.50	64	1	880	85	100	890	3.50	2.50
Ditto	1DNS	209	58.5	31	14.7	14.3	77.4	.55	64	2.50	69	1	900	75	90	920	2.75	2.00
"	2DNS	306	58.2	32	14.9	14.2	77.8	.52	64	2.50	69	2	910	85	90	915	3.00	2.25
"	3DNS	210	56.8	31	15.4	14.7	76.0	.52	61	2.50	70	1	890	80	85	940	3.50	2.00
"	4DNS	65	54.8	30	16.2	15.6	74.7	.52	63	2.50	72	2	950	80	80	985	4.25	2.75
"	5DNS	28	53.9	29	16.0	14.9	74.0	.51	62	2.50	72	1	905	95	95	950	3.25	2.25
"	1NS	28	58.4	34	12.7	12.2	76.3	.52	62	2.50	57	1	815	85	85	815	3.25	2.75
"	2NS	42	57.4	34	13.0	12.4	76.9	.52	62	2.75	55	2	793	80	80	825	3.50	2.50
"	3NS	23	55.1	33	13.4	12.6	75.6	.51	64	2.75	64	1	858	85	95	835	3.75	2.50
"	3NS	52	56.3	33	13.3	12.6	76.3	.52	64	2.50	55	2	845	80	90	835	3.50	2.50
reat Falls, Mont.	1HDNS	100	60.5	28	13.9	13.2	74.7	.50	62	2.50	65	2	810	85	90	865	2.75	2.75
Ditto	1DNS	246	58.7	30	14.6	13.9	74.7	.53	62	2.50	69	2	865	80	85	900	3.00	2.25
"	2DNS	157	57.4	29	14.9	14.4	74.6	.50	62	2.50	71	2	893	85	95	925	3.75	3.00
"	2DNS	14	58.8	29	14.5	13.8	74.7	.49	62	2.50	71	2	850	75	95	895	3.00	2.00
"	3DNS	24	58.6	28	15.0	14.4	75.0	.51	62	2.50	68	2	880	70	90	925	3.00	2.00
"	3DNS	112	57.4	30	15.4	14.6	74.3	.49	62	2.50	68	2	915	85	85	935	3.50	2.25
"	3DNS	160	56.6	30	15.3	14.9	74.5	.50	62	2.50	71	2	920	75	90	950	3.75	3.25
"	4DNS	15	54.6	28	16.6	15.8	73.5	.50	61	2.50	71	2	945	75	90	995	3.75	3.25
inneapolis, Minn.	1HDNS	86	60.4	30	13.9	13.2	74.8	.55	63	2.25	56	2	830	80	95	865	2.50	1.75
Ditto	1DNS	144	58.6	31	14.7	13.8	75.1	.53	63	2.50	64	2	850	75	85	895	2.75	1.75
"	2DNS	58	57.7	32	14.7	14.0	76.2	.51	61	2.50	68	2	830	70	85	905	3.00	2.50
"	3DNS	118	56.1	33	14.6	13.8	75.4	.51	60	2.50	69	2	883	75	80	895	3.00	2.75
"	4DNS	29	54.5	30	15.6	14.5	71.8	.51	59	2.50	71	2	850	75	90	930	3.50	2.00
"	5DNS	13	52.6	28	16.1	15.1	71.1	.55	60	2.50	72	1	715	65	80	960	3.75	1.50
"	1NS	16	58.7	31	12.9	12.3	76.8	.55	61	2.50	55	2	730	75	80	820	4.00	3.75
"	2NS	22	57.4	33	13.0	12.3	76.3	.54	61	2.50	52	1	738	90	85	820	3.50	2.50
"	3NS	19	56.0	32	13.1	12.5	74.9	.52	60	2.50	62	1	763	85	85	830	3.25	2.25
"	4NS	12	62.0	29	14.2	13.1	75.4	.54	59	2.50	71	2	785	75	80	860	3.25	2.50

1/ See text for methods and moisture basis for various quality determinations.

Strains and Varieties of Current Interest

Each year many new wheats are tested along with the leading commercial varieties for chemical, milling, and bread-baking quality. The data on 3 recently named varieties and 3 strains of current interest with averages of comparable samples of a number of approved hard red spring varieties are shown in table 5.

Canthatch (C.I. 13345)

Canthatch (C.I. 13345), the newly named Canadian variety from a cross of Thatcher^{6} x Kenya Farmer (C.T. 233-R.L. 2936) was received from 13 stations in 1959. Comparable milling and baking tests of this strain showed it to be similar to Thatcher for nearly all of the quality properties for which it was tested.

Canthatch averaged only slightly higher in test weight and protein content than Thatcher. They had the same water absorptions, pearling index values, and oxidation requirements. Both were similar in flour yields, flour ash content, dough-mixing times, sedimentation values, loaf volumes, crumb color, and crumb grain. One of the favorable properties of Canthatch is its excellent grain in the bread. Canthatch milled satisfactorily. The yellow crumb color (low score) in the bread from Canthatch appears to have been carried over from Thatcher, one of its parents. The dough properties (development time and mixing tolerance) according to the mixogram tests were strong and equal to, if not slightly better than, those of Thatcher. The doughs at the time of panning were strong, elastic, and pliable, favorable properties of the strain.

Pembina (C.I. 13332)

Ten comparable milling and baking tests show this recently named Canadian variety to be about equal to Thatcher in many of its characteristics. It milled satisfactorily, producing a slightly higher yield of flour than Thatcher. It had the same test weight, ash content of flour, water absorption, oxidation requirements, and crumb color of the bread as Thatcher. The protein content of the wheat was materially higher than that of Thatcher (0.7 percent). As indicated by the loaf volume of the bread, the quality of the gluten in Pembina appears to be slightly poorer than expected according to the flour protein. The loaf volume of the bread for Pembina averaged 885 cc. for 15.1 percent flour protein, compared to Thatcher with a loaf volume of 897 cc. and protein content in the flour averaging 14.3 percent, or 0.8 of a percent lower. The internal bread characteristics, crumb color and grain, were similar to those in the bread from Thatcher. The dough properties, development time, and mixing tolerance were strong. The doughs at the time of panning were strong, elastic, and pliable.

Table 5.—Average quality characteristics of a number of strains and varieties of current interest compared with approved varieties of hard red spring wheat.[1/]

Variety or Cross	No. of samples	C.I. Nursery, State or Sel. No.	Test weight	Pearling index	Protein		Flour		Absorption	Mixing time	Sedimentation value	Optimum baking method				Expected loaf volume	Quality of dough from mixogram tests [2/]	
					Wheat	Flour	Yield	Ash				Bromate	Loaf volume	Crumb Color	Crumb Grain		Development time	Mixing tolerance
			Lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Min.	Ml.	Mg.	Cc.	Score	Score	Cc.	Min.	Min.
Canthatch	13	13345, CT 233	57.4	27	15.3	14.5	73.7	52	65	2.62	63	2.0	887	74	91	930	3.58	2.92
Thatcher	13	10003	57.0	27	15.0	14.3	73.9	54	65	2.69	60	2.0	885	73	93	920	3.33	2.42
Pembina	10	13332, CT 229	57.6	30	15.7	15.1	74.3	53	65	3.20	71	2.0	885	74	92	960	4.25	3.62
Thatcher	10	10003	57.5	27	15.0	14.3	73.9	53	65	2.58	60	2.0	897	74	94	920	3.12	2.12
ND 81 x Lee	6	13349, ND 137	59.8	33	15.7	14.8	74.1	58	68	2.83	64	2.0	871	78	88	945	3.55	3.25
Lee	6	12488	59.8	32	15.4	14.8	75.2	56	68	2.92	66	2.0	875	89	94	945	3.70	3.30
II-44-29 x Lee[3]	2	II-53-562	59.4	33	15.6	14.9	74.8	52	68	2.38	70	2.0	854	75	95	950	5.00	5.25
Ditto	2	II-53-567	58.8	33	15.9	15.0	75.8	53	68	2.63	70	2.0	868	77	97	955	4.00	3.75
Lee	2	12488	59.2	32	16.2	16.0	74.9	56	70	2.38	65	3.0	907	88	95	1055	3.25	2.50
Sawtana	13	13304, B-51-9	55.9	32	15.3	14.6	74.4	45	62	2.15	65	1.5	896	80	86	935	3.25	1.50
Rescue	13		58.9	33	15.3	14.6	73.5	45	61	2.11	68	1.2	929	78	89	935	3.37	1.33
1953 x Lee	8	13242, B-52-91	59.0	34	15.0	13.9	73.0	40	63	2.06	68	1.6	878	89	93	900	2.75	1.50
Lee	8	12488	59.1	34	16.4	15.2	71.9	47	64	2.13	64	1.6	893	88	91	965	2.25	1.25
Selkirk	8		56.7	33	15.5	14.7	73.9	45	64	2.16	69	2.0	914	86	92	940	3.50	1.50

1/ See text for methods and moisture basis for various quality determinations.
2/ Not determined for all samples baked into bread.

N.D. 81 x Lee (C.I. 13349)

Six comparable tests of N.D. 81 x Lee show that it is very similar to Lee for most of the characteristics. The only exceptions were the flour yield, which was 1.1 percent lower, and the crumb color and grain of the bread, which were 11 and 6 points lower, respectively. A number of the station samples milled only fair and produced flours of relatively high ash contents. The handling properties of some of the doughs at the time of panning were mellow, moderately elastic, and pliable, while others were strong and bucky. The quality of the doughs according to the mixogram tests were similar to Lee.

II-44-29 x Lee[3]

Two samples each of 2 promising selections from a cross of II-44-29 x Lee and backcrosses to Lee were compared with comparably grown samples of Lee. These selections are II-53-562 and II-53-567. One of the most significant and promising quality properties of these 2 selections from this cross was their very strong dough characteristic as shown by the long development times and mixing tolerances according to the mixogram tests. Both selections were better in this respect than Lee, with selection II-53-562 stronger of the two. Both selections were similar in chemical, milling, and baking quality. Selection II-53-562 had a higher test weight and a lower flour yield than II-53-567. This is in addition to the dough properties according to the mixogram tests as already mentioned. In comparison with Lee, the selections were lower in protein content, ash content of flour, and crumb color of bread. The flour yield was highest for selection II-53-567, exceeding that of Lee. Both of the selections required about one-third less oxidation for optimum loaf volume than Lee. The milling properties of both selections were satisfactory.

The doughs handled satisfactorily at the time of panning, being strong, elastic, and pliable. These are promising bread strains.

Sawtana (C.I. 13304)

The recently named Montana variety, Sawtana, a selection from the cross Rescue x 1831, has been found satisfactory as a replacement for Rescue. Thirteen comparable tests of Sawtana (C.I. 13304), starting with the crop year 1952, show that with the exception of a few properties it was very similar to Rescue in chemical, milling, and baking quality. The test weight was 3.0 pounds lower than that of Rescue and the flour yield was 0.9 percent higher. Sawtana appears to have milled satisfactorily and in some years was excellent. The yield of flour from it was remarkably high for a wheat of only 55.9 pounds test weight. This variety produced a satisfactory loaf volume and about that expected for the flour protein content. The quality of the doughs according to the mixogram tests was similar to Rescue. The doughs at the time of panning were good on the average, being elastic and pliable.

1953 x Lee (C.I. 13242)

Eight comparable quality tests of 1953 x Lee (C.I. 13242, B52-91) with Lee and Selkirk have been made, starting with the 1954 crop. 1953 x Lee was similar to Lee in a number of characteristics for which comparisons have been made. It was much like Lee in test weight, pearling index value, absorption, dough-mixing time, and the bread-making properties, e.g., loaf volume, oxidation requirements, crumb color, and grain. The oxidation requirement of this strain was lower than that of Selkirk, a favorable property. It was lower in protein content (1.4 percent in wheat and 1.3 percent in the flour) than the comparably grown Lee. It averaged 1.1 percent higher in flour yield than Lee, which had about the same test weight. One favorable property of this strain was its somewhat lower ash content of flour than either Lee or Selkirk. 1953 x Lee had an average flour ash content of 0.40 percent while Selkirk tested 0.45 and Lee 0.47. It was moderately strong in dough characteristics, being elastic and pliable. It differs from Selkirk in that it was higher in test weight (2.3 pounds), lower in protein content (0.5 percent in the wheat and 0.8 percent in the flour), and lower in flour ash content (.05 percent). It needs about 25 percent less oxidation for optimum bread than Selkirk. Otherwise, it was very similar to Selkirk for the other characteristics not mentioned.